SPECIAL: 3RD ANNUAL GUIDE TO ASTRONOMY

ASTRONOMY®

Running Rings around Neptune
Space Station in the Balance
Inside Celestron's Ultima 8

May 1989 U.S. $2.50
U.K. £1.50
Can. $2.95

ICD 08070

The Trifid and Lagoon: Nebulae of Summer

08070 05
0 771855

Meade® SCT's—The finest, and more:

The Meade Photo-Visual Accessory Package, shown with standard-equipment SP 26mm eyepiece.

A $750 Meade Accessory Package ...Absolutely FREE!

Through May 31, 1989, Meade Instruments will give you over $750 in optional accessories when you buy a Meade 8″ or 10″ Schmidt-Cassegrain telescope!

It's this simple:

1 Buy any of the following Meade Schmidt-Cassegrain telescope models: 10″ Model 2120/LX5; 8″ Model 2080/LX6; or 10″ Model 2120/LX6. Call or visit any authorized Meade dealer in the USA and Canada and make your best deal.

2 Mail the completed Telescope Registration Card (included with each instrument), along with a copy of your invoice for the telescope you have purchased, to Meade Instruments.

3 We will ship direct to your door and **free of charge** the Meade Photo-Visual Accessory Package described here (see inset photo, opposite page, and box, this page).

This offer is valid only in the USA and Canada and applies only to telescopes purchased ***between March 1, 1989, and May 31, 1989.*** *Registration Cards and invoice copies sent to Meade Instruments must be postmarked not later than June 15, 1989.*

The Meade Photo-Visual Accessory Package includes most of the accessories you'll ever need for advanced photographic and visual applications of the instrument. All accessory components listed in the Package are the exact same, brand-new, premium-grade Meade accessories that we sell every day.

Regular retail value of the Meade Photo-Visual Accessory Package, *without* adding the value of the standard-equipment SP 26mm eyepiece, is $768.

Each Meade Photo-Visual Accessory Package includes:

1—Series 4000 Super Plössl 6.4mm Eyepiece. *List price: $140.*
1—Series 4000 Super Wide Angle 18mm Eyepiece. *List price: $240.*
1—Series 4000 Super Plössl 26mm Eyepiece (packed with all LX5 and LX6 telescopes as standard equipment).
1—Series 4000 #140 2X Telenegative Barlow Lens. *List price: $120.*
4—Photo-Visual Color Filters (1 each: #8 Yellow, #23A Red, #80A Blue, and Polarizer). *List price: $88.*
1—T-Adapter for prime-focus photography. *List price: $50.*
1—Tele-Extender for eyepiece-projection photography. *List price: $50.*
1—Foam-lined, all-metal Meade Deluxe Accessory Case accepting all of the above accessories. *List price: $60.*
1—Meade 24 pg. Star Charts, printed on heavy, coated stock, ideal for field use. *List price: $20.*
List price total: $768.

Consider the capability you'll have with the Meade Photo-Visual Accessory Package:

☐ *A range of eyepiece magnifying powers from moderate (using the SP 26mm) to high (with the SP 6.4mm), and including the magnificent super wide angle capability of the SWA 18mm with its 67° field and pinpoint edge-to-edge field corrections.* And, because each of these eyepieces has been selected from the Meade Series 4000, you'll know that you're using the finest eyepieces—bar none—ever manufactured for serious telescopes.

☐ *Use the Meade #140 2X Telenegative Barlow Lens to double the magnifying power of each eyepiece above.* The #140 is the only Barlow currently available that incorporates a 3-element, air-spaced lens, yielding absolutely uncompromised image quality. The SWA 18mm eyepiece, used in conjunction with the #140 Barlow, is a superb combination of wide field-angle *and* moderately high power.

☐ *Meade photo-visual color filters thread into all of the eyepieces listed above and enhance visible detail on the Moon and planets.* Use the #8, #23A, or #80A on Mars, Jupiter, or Saturn to reduce irradiation effects and to bring out subtle detail in surface or atmospheric phenomena. Use the Polarizer, or the Polarizer piggybacked with the #8 filter, to reduce glare and enhance contrast during lunar observations.

☐ *The T-Adapter is the basic means of photography through the telescope.* Used with your 35mm camera and an appropriate T-mount, your Meade 8″ or 10″ telescope becomes an incredibly powerful terrestrial or astronomical photographic system. *The Tele-Extender permits the projection of enlarged images onto the camera film plane,* a technique particularly useful in lunar and planetary photography.

☐ *Meade Star Charts provide a valuable field reference source for the location of over 1000 deep-space objects,* and include detailed star maps of the skies, along with listings and positions of important objects on a constellation-by-constellation basis.

Meade 8″ and 10″ SCT's—the World's leading Schmidt-Cassegrain telescopes—incorporate exclusive features so advanced that no other manufacturer has yet been able to match them. See your authorized Meade dealer for immediate delivery.

And, with the Meade Photo-Visual Accessory Package available free, there has never been a better time to buy.

Bulletin LX6—Available at no charge, includes complete technical specifications, descriptions, and applications, with astrophotos, of Meade LX6 models.

Complete Catalog Package #89C—$3.00—Includes catalogs and bulletins on the entire range of Meade astronomical telescopes, Series 4000 eyepieces, and accessories.

Dealer Locations and Assistance—For your nearest Meade dealer location, or for free telescope information and assistance, call Meade Instruments toll-free from anywhere in the continental U.S.A. (except California): **1-800-854-7485.** From all other areas, including California, call direct (714) 556-2291.

Meade Instruments Corporation
World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
1675 Toronto Way, Costa Mesa, California 92626 ☐ (714) 556-2291

©1989

ON THE COVER: Two popular summer deep-sky targets are the Lagoon (lower left) and Trifid nebulae. A planetary interloper, Uranus, was also captured in this photo taken last summer. The planet is the bright "star" midway between the two nebulae. Photo by Tony Hallas and Daphne Mount.

THE MOON EDGES PAST VENUS over Tulsa, Oklahoma, during their conjunction April 19, 1988. Photo by Bill Sterne.

ASTRONOMY®

May 1989 Vol. 17, No. 5

24 Space Station in the Balance
Will the nation stand behind NASA's Space Station? By Stephen Cole.

36 Running Rings around Neptune
Voyager 2 will give us our first pictures of Neptune's odd rings. By Richard Berry.

44 Elliptical Galaxies Forged by Collision
Elliptical galaxies could be the result of colliding spiral galaxies. By Karen Hartley.

50 1989 Directory of Observatories and Planetariums
Browse through our third annual guide to astronomical places to visit.

60 ASTRONOMY Sky Almanac

70 1989 Directory of Astronomy Clubs
Get involved with one of the over three hundred amateur astronomy clubs listed.

76 1989 Summer Meetings and Events
An astronomy-filled summer awaits you!

78 ASTRONOMY Tests Celestron's Ultima 8
We've evaluated this new telescope inside and out. By Robert Burnham.

84 Get Ready for Pluto at Its Best
Join the small group of observers who have seen Pluto. By Richard L. Talcott.

90 Dramatically Diverse Globulars
Who says globular clusters all look alike? By Chris Schur.

Departments

6 Behind the Scenes
6 Letters
8 Viewpoint
A Blow to Astronomy
10 AstroNews
Mysterious Pulsar Found in Supernova 1987A
18 Space News
Satellites on a String
20 Amateur News
Winter Star Party
98 Reader Reports
Supernova in M66
104 Forum
106 Astronomy Reviews
112 Astronomy Products
116 Readings and Resources
116 Credits
118 Advertiser Index

ASTRONOMY (ISSN 0091-6358) is published monthly by Kalmbach Publishing Co., 1027 North 7th Street, Milwaukee, WI 53233. Copyright © Kalmbach Publishing Co., all rights reserved. Material in this publication may not be reproduced in any form without permission. Second-class postage paid at Milwaukee, WI, and additional mailing offices. POSTMASTER: Send address changes to ASTRONOMY, 1027 North 7th Street, Milwaukee, WI 53233. Questions about subscriptions and product orders: **(414) 272-2060** weekdays, 8:30 a.m. - 4:45 p.m. Allow six to eight weeks for new subscriptions and changes of address. New subscriptions start with current issue. Subscription price: 1 year, $24. All foreign: add $9 per year; please remit in U.S. funds. Send editorial and business inquiries and submissions to the address above. Telephone: (414) 272-2060. Not responsible for unsolicited materials. ASTRONOMY is indexed in *The Reader's Guide to Periodical Literature*. Microfilms of ASTRONOMY available from University Microfilms, Inc., 300 North Zeeb Road, Ann Arbor, MI 48106. Printed in the U.S.A.

Behind the Scenes

ASTRONOMY IS FOR EDUCATORS

Since its earliest years ASTRONOMY has filled an educational need. Teachers would call us asking for permission to reprint articles or make slides for their classes from diagrams in our feature stories. We even got calls from teachers wanting to know how to start teaching astronomy.

In 1979 we founded *Odyssey*, the young people's magazine of space and astronomy. *Odyssey* has grown rapidly in its ten years and has earned praise from parents and educators alike.

But when we investigated what's going on in our schools last fall (see "Astronomy in Our Schools" by Stephen Cole, September 1988), it became clear that we needed to do more. The growing interest in teaching astronomy was creating a greater need for information and support.

So we decided to help.

Beginning this September, we will publish a special supplement to ASTRONOMY called *Astronomy Educator*. It's intended for everyone who teaches astronomy. Under the direction of ASTRONOMY's managing editor Stephen Cole, *Astronomy Educator* will run the gamut of astronomy education — elementary school through college.

We believe *Astronomy Educator* will help astronomy teachers all across the United States by presenting articles on trends in astronomical education, contributions from well-known astronomy educators, and notices of workshops and meetings. *Astronomy Educator* will also feature ready-to-go classroom activities based on stories in ASTRONOMY.

Our goal in starting *Astronomy Educator* is to support and strengthen astronomy education in the United States. We believe that by helping those people who introduce future citizens to the universe we live in, we're not just supporting astronomy but education in all the sciences.

If you want to receive *Astronomy Educator*, call (414) 272-2060 and ask for Customer Service. Or see our announcement on page 111.

Through *Astronomy Educator*, ASTRONOMY is proud to support the nation's astronomy teachers. As readers of ASTRONOMY know, astronomy is a great way to capture children's imagination, stir their curiosity, and launch them on what often becomes a lifelong pursuit.

Sincerely,

Richard Berry

ASTRONOMY

Richard Berry Editor-in-Chief
Stephen Cole Managing Editor
Thomas L. Hunt Art Director
Robert Burnham Senior Editor
Jeff Kanipe Associate Editor
David J. Eicher Assistant Editor
Kristine R. Majdacic Assistant Editor
Richard Talcott Assistant Editor
Todd Graveline Assistant Art Director
Patti L. Keipe Typesetter
Margaret Sullivan Editorial Assistant

Robert A. Maas Publisher
Dana-Lynne Terry Advertising Sales Manager
Susan Poole Marketing Director/Products
Gary Dolzall Marketing Director/Magazines

Advertising Department:
(800) 558-1544

Advertising Representative — NE Region
Adpress, Inc., New York, NY 10016
(212) 679-1710

U.S. Newsstand Distribution
I.C.D., The Hearst Corp., New York, NY 10019

Canadian Newsstand Distribution
Telemedia Dist., Toronto, Ontario M4S 3B3

World Newsstand Distribution
Boarts International, Inc., New York, NY 10019

Letters

Mail-Order Satisfaction

Since I began my astronomy hobby, I have been misled by vendors and advertisers about product availability. Items are often advertised as "available now" or "new and in stock," and when I place my telephone credit card order, I am told the item is in stock and will be shipped immediately. But often the items aren't shipped immediately, and when I call to complain about late orders, I am told the "in stock" items are back-ordered. — *Norm Farrington, Council Bluffs, Iowa*

— Kalmbach Publishing Co. has an effective complaint-resolution process for subscribers who have problems ordering from any of our advertisers. If you have a problem with an advertiser, send a letter stating the specific nature of the complaint to Walter Mundschau, president of Kalmbach.

He will contact the advertiser to request a solution to the problem. If the advertiser refuses to comply after a stated amount of time, ASTRONOMY will refuse further ads from that company.

Crime Fighter or Criminal?

Alan Miller stated that amateur astronomers can help reduce crime by keeping an eye on their neighborhoods (Letters, January 1989), but I have found that amateur astronomers themselves often attract the attention of the police.

Many years ago my brother, a friend, and I set up our telescope in an unfenced school yard. We were somewhat lost and it turned out that we were trespassing. Our dark-adapted eyes were blinded as an approaching police car flooded the area with very bright spotlights. After a quick check the police determined that we were harmless, but we were warned to stay away from the buildings.

Although the police were professional and courteous, this type of incident certainly doesn't improve an observing session. It's important to make sure you're not trespassing, but if the police do stop you, don't suddenly turn around with some gadget in your hand that could be mistaken for a gun! — *Ron Cardinale, South San Francisco, California*

Caroline's Comets

I hope your recent article "William Herschel: Pioneer of the Stars" by Brian Jones (November 1988) serves to remind people of the great astronomical contributions of William's sister Caroline. Her work was overshadowed by that of her brother, which isn't unexpected for a time when science was almost exclusively a male domain.

There is now an excellent opportunity

DEAR MR. NAGLER:

Several years ago, I purchased a 10" Schmidt-Cassegrain telescope. On this new instrument, I carefully compared the performance of the most respected brands of eyepieces before concluding that the **Tele Vue** Plössls were giving me the best views. Along with 4 of your Plössls (55, 26, 17 and 13mm) and your 2.5x Barlow, I bought a Giant Off-Axis Guider, which I frequently use as a telecompressor. Although I have always been pleased with your eyepieces, there are limits to just how much a long-focal-length telescope can be telecompressed! ■

For over three years, I have wanted a second instrument for rich-field observing and photographing. Although your **Renaissance** is most impressive, it just wasn't quite the instrument I wanted and the **Oracle** was a bit too small. Then came **Genesis.** Knowing what a stickler you are for details in both design and production, plus my total satisfaction with your eyepieces; sight unseen, I bought a **Genesis** based solely on those facts and your ads in the magazines. ■

I took delivery of my **Genesis** at the Texas Astronomical Society's meeting on 7/22/88. Even with all the light pollution in that North Dallas parking lot, my new **Tele Vue** 32mm Wide Field eyepiece, at less than 16x, clearly resolved Saturn's rings as separate from the disc. When a friend asked to try his 12mm Nagler-II with his 3x Barlow, I knew I had bought a "winner." The Cassini Division was as sharply defined as I have ever seen it plus the surface and ring detail was second only to a view I once saw under a Texas Star Party's dark skies through a nearly $20,000, 10.7" f/15 Maksutov! ■

The reason for this letter is simple. I have now had my first opportunity to take my new **Genesis** out to the T.A.S.'s dark-sky observing site (100 miles north of Dallas). In short order, the **Genesis** had attracted a group of experienced observers (most holding full Messier Certificates) away from their larger telescopes. Simply, **Genesis** stole the show! Except for an occasional comparison view, my 10" Schmidt-Cassegrain sat idle because I was seeing far greater clarity and detail with my new **Genesis.** Although I had with me a full set of filters (Deep Sky, U.H.C., O-III and H-β), none were ever used. ■

While I had anticipated a gorgeously resplendent Double Cluster, it was truly more dazzling than I expected. But, some real surprises lay ahead. Take M-33 in Triangulum: 4" just isn't enough aperture for such a diffuse spiral, right? WRONG! With the 32mm Wide Field, I was seeing tremendous detail in a galaxy over 1/3 the width of the field. I could write paragraphs describing a California Nebula covering half the field plus all the glorious sights through Sagittarius and Scorpius like the Lagoon, Trifid and M-21 all in the same field; or, four gleaming globulars, M-22 & 28 with NGC-6638 & 6642. ■

While the Great Andromeda Galaxy (M-31) spread across more than 2/3 of the field, we were all alternating time at the eyepiece, trying to see who could count the most dust lanes. It was more beautiful than even the photographs from the leading observatories. I have never seen M-110 appear as large relative to M-31. One observer even held his hand in front of the eyepiece and suggested that we try observing a projected image! While that may have been beyond even **Genesis'** capability, it does prove we were looking at no dim M-31. There was a debate over which eyepiece provided the better view: the 13mm Nagler's greater contrast and detail or the 32mm Wide Field's greater coverage. Each outperformed the other in its own way and both provided splendid views. ■

All night, comments from seasoned observers included a thesaurus-full of one word expletives of praise, wonder and astonishment. While glued to the eyepiece, other comments included: "...but this is ONLY a 4-inch" to "Boy! You sure made no mistake in buying this one" and "Oh, No!... How am I ever going to make my wife see the need?". One observer even yelled to a friend acoss the field, "Get over here if you want to see what Rich Field is SUPPOSED to look like." Personally, I can hardly wait to start taking astrophotos with it. ■

In case you could have possibly missed my point: I am totally enthralled with my new **Genesis.** Mr. Nagler, what you have created with your **Renaissance** and **Genesis** telescopes has filled a void, beyond binoculars and yet still permitting the beauty of deep sky objects to be viewed 'in context' without resorting to the usual solution of over-magnification that reveals detail at the expense of sacrificing perspective. ■

Because our dark sky observing location attracts late-night dewing and humidity, I appreciate your design consideration of including the fluorite element as a totally internal component, inaccessible to dew, condensation or scratches. ■

It would have been impolite of me not to write and tell you just how much of a Big Bang your **Genesis** telescope has already created in my deep sky observing. ■

Appreciatively yours,

Kent E. Ledlow

Tele Vue®

20 Dexter Plaza, Pearl River, NY 10965 (914) 735-4044

to give Caroline, who discovered eight comets on her own, the recognition she deserves: name the *Comet Rendezvous/Asteroid Flyby* spacecraft the *Caroline Herschel*. — *Ralph Buttigreg, Westmead, New South Wales, Australia*

Portability Important in a Scope

I want to stress how important portability is when deciding on the size of your next telescope.

I've used both a 10-inch and a 4-inch Schmidt-Cassegrain, and the difference in portability has determined which size I'll buy. The 10-inch takes about thirty minutes and two people to set up and polar align. It weighs about fifty pounds. The 4-inch, on the other hand, takes about ten minutes to set up and weighs about twenty-five pounds.

I can afford to buy a 8-inch SCT, but I'm not going to. I'm going with a 4-inch SCT because I'm willing to sacrifice aperture for portability. I don't want a telescope I'll never use.

If you're looking for a new telescope, consider portability. It is directly related to how much you will use your scope. — *Doug Norton, Summerville, South Carolina*

The History of Ideas

I found two aspects of "The Triumphant Grand Tour of *Voyager 2*" by Mark Littmann (December 1988) especially intriguing. The first was the quotes by the scientists who developed the idea that made the four-planet mission possible by gravity assist and who solved the in-flight problems of the mission.

The second was the detailed credit given to the scientists whose previous discoveries contributed to the success of the *Voyager* mission. — *C. L. Sainsbury, Evergreen, Colorado*

Correction

The TEREK imager on board the *Phobos 1* spacecraft was described in "The Many Faces of the Sun" by Gerrit L. Verschuur (March 1989) as a Czechoslovakian-built instrument. The imager was actually designed and built by the Astronomical Institutes of the Czechoslovakian Academy of Sciences and the Lebedev Institute of the Soviet Academy of Sciences.

ASTRONOMY welcomes comments, suggestions, corrections, and additional information on articles and astronomy. Send your letters to: ASTRONOMY Letters, 1027 North 7th Street, Milwaukee, WI 53233. Letters may be edited for length and clarity. □

Viewpoint

A BLOW TO ASTRONOMY

by Gerrit L. Verschuur
Radio astronomer and author of Interstellar Matters *(Springer-Verlag, 1989)*

The collapse of the 300-foot radio telescope in Green Bank, West Virginia, on November 15, 1988, was a devastating blow to astronomy and now bears the hallmarks of a continuing tragedy. If the 300-foot telescope is not replaced, the damage will resonate through astronomy for the next century.

No other telescope can fill the research void left by this loss. The 300-foot radio telescope was ideal for making large-scale surveys that telescopes such as the Very Large Array (VLA) can never undertake.

How many discoveries will be lost if the Green Bank radio telescope is not replaced?

The only other Northern Hemisphere instruments in its class are the aging Jodrell Bank radio telescope in England, which is not an international facility, and the Bonn telescope in West Germany, which is seldom used at longer wavelengths because of the stifling effects of radio interference.

Radio interference was never a serious problem for the 300-foot telescope because it was located in the National Radio Quiet Zone, a region unique in the world for its ban on extraneous radio noise. The zone encompasses 21,000 square miles of West Virginia and Virginia and was established in 1958 to protect the operations of the National Radio Astronomy Observatory at Green Bank and the Naval Research Observatory at Sugar Grove, which has a large dish that never went into operation.

Federal Communications Commission regulations require that anyone seeking to operate a transmitter in this zone give the NRAO full details. The NRAO then analyzes the impact of the proposed transmitter on its research activities and either comments or files an objection. As a result, radio frequency interference from fixed transmitters has been kept to a very low level within the zone.

No wonder, then, that its radio-quiet location and its size combined to make the 300-foot one of research astronomy's most valued resources. Its loss leaves an enormous void in the astronomer's repertoire of essential instruments. A single-dish radio telescope has certain advantages over a synthesis instrument such as the VLA. It receives radio energy from a larger area of sky (usually 5 to 10 arcminutes across) and is thus an ideal instrument for surveying the entire sky.

The 300-foot was just completing a second all-sky survey at the 6-centimeter wavelength when it collapsed. In the first pass it cataloged 60,000 radio sources, more than all the sources ever observed by all of the other radio telescopes in the world combined. When the new survey is analyzed, the catalog will include 100,000 sources. A study of these sources will help astronomers better understand the evolution of quasars and galaxies in the early universe.

The telescope also discovered about one quarter of all pulsars. One of the most important discoveries was the Crab Nebula pulsar, which firmly tied the existence of these objects to supernovae. The continuing studies of pulsars require very large blocks of observing time at longer wavelengths. Such time is not available on other radio telescopes, especially those capable of operating at shorter wavelengths, where astronomers interested in studying interstellar molecules have a monopoly.

Senators Byrd and Rockefeller of West Virginia have expressed their desire, shared by West Virginians and the majority of astronomers, to see the 300-foot telescope replaced by a state-of-the-art equivalent. Yet Erich Bloch, director of the National Science Foundation, has argued that because no plans existed to replace the telescope, it shouldn't be rebuilt. But why would such plans have ever existed? In this time of fiscal constraint, radio astronomers did not see the need to argue for a replacement scope while the 300-foot telescope was functioning so well.

Without a replacement telescope to provide crucial observational data, most of the research programs that were in full flower will die. And without a similar instrument in the world to take up the slack, it is likely that many programs will never be completed. How many discoveries will be lost? How many breakthroughs left unrealized?

If we fail to replace the 300-foot radio telescope at Green Bank, we will look back a half-century hence and regret the decision that caused one loss to become an even greater tragedy. □

Climb Aboard The Most Awesome Combat Aircraft in the World. Be there...

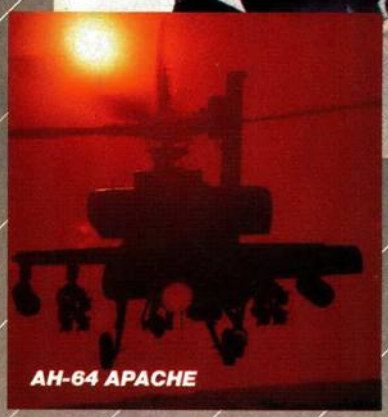
IN THE COCKPIT

The Video Library of Today's Airpower

Spectacular Air Combat Action!

BONUS! Includes Actual Footage of Jan. 4, 1989 Shootdown of Libyan MIG-23's.

Attack Aircraft in Action!
Carrier Launched Strikes!
Soviet Aircraft Up Close!
High Flying Spy Planes!
...And Much More!



Stand an F-15 Eagle on its tail, and feel its twin 23,000 lb. thrust engines and afterburners rocket you to 60,000 ft.! Catapult off a flat top in an F-14 Tomcat, roaring from 0 to 170 mph in just 3 seconds!

Now you can experience the thrill of flying the most formidable combat aircraft in the world — planes of electrifying capabilities, astonishing supersonic speeds, and dazzling arrays of weaponry. It's all in a new, all-action video library, *IN THE COCKPIT.* Featuring spectacular combat footage and narration written by leading experts on military aviation.

Six Action-Packed Videos

You'll receive six exciting videos, filled with authentic, breathtaking action. Go on a mission aboard the finest reconnaissance aircraft built, the incredible SR-71 Blackbird in **Spies in the Skies.** Fly with dedicated spy planes like the ones used over Cuba and Vietnam. In **Red Star** see close-ups of the new Soviet Mig-29. See the Famous Hind and Halo attack helicopters in remarkable footage from Nicaragua and Afghanistan. Fly carrier launched air strikes against North Vietnam in **Flat Tops,** and search for Soviet submarines in the Hawkeye.

In **Eagles in the Sky,** fire Phoenix missiles from the Navy's F-14 Tomcat, and fly the Air Force's F-15 Eagle and F-16 Falcon on air superiority missions. In **Fly Low, Hit Hard** see ground attack action in Vietnam with the nimble A-4 Skyhawk and the most feared ground attack aircraft in the world like the Thunderbolt II and the battle-proven Israeli Kfir. And in **Target Tank,** witness combat helicopter action on the modern battlefield.

Attractively Priced, Convenient Monthly Installments

IN THE COCKPIT is available exclusively from Easton Press Video. Each set of six videos-60 minutes each- comes in a handsome library case and is priced at just $149.75† payable in convenient monthly installments. To order, simply return the attached coupon or call the Toll-Free number. If you are not totally satisfied, return your set within 15 days for a full refund. Order today to avoid disappointment!

† plus 4.75 shipping/handling per set.

CALL TOLL FREE 1-800-367-4534
In Conn. call: 1-855-8717

© 1989 MBI

Easton Press Video
47 Richards Avenue
Norwalk, Conn. 06857

Satisfaction Guaranteed

For Fastest Service Call Toll-Free: 1-800-367-4534
In Conn. call: 1-855-8717

Yes! Please send me the *IN THE COCKPIT* video library. I understand only VHS format is available.

Name _____
PLEASE PRINT CLEARLY

Address _____

City/State/Zip _____

Signature _____
(All orders subject to acceptance)

Charge each of 6 equal monthly installments of $25.75* to my credit card:
☐VISA ☐MasterCard ☐American Express ☐Diners Club

Credit Card No. _____ Exp. Date

☐ I prefer not to use a credit card and will pay by check. Enclosed is my deposit of $50.00*. I will pay the balance of $104.50* in three monthly installments of $34.83* each.

Allow 3 to 6 weeks for shipment.
*CT residents add 7½% sales tax.

MYSTERIOUS PULSAR FOUND IN SUPERNOVA 1987A

Astronomers have discovered a pulsar spinning nearly two thousand times a second deep inside supernova 1987A. The discovery of the pulsar — the remains of the supergiant star that exploded and gave birth to 1987A — had been eagerly anticipated by astronomers, who believe that most, if not all pulsars are formed in supernova explosions. However, this pulsar rotates much faster and has a much weaker magnetic field than expected and seems to have an unexplained companion object: surprises that now present astronomers with an unexpected host of puzzles.

A group of fourteen researchers, led by Carl Pennypacker of Lawrence Berkeley Laboratory, Jerome Kristian of the Carnegie Institution of Washington, and John Middleditch of Los Alamos National Laboratory, has been searching for the 1987A pulsar since shortly after the explosion occurred two years ago. On January 18 they observed the supernova for seven hours with the 4-meter telescope at Cerro Tololo Interamerican Observatory in Chile. A Cray II supercomputer at Los Alamos analyzed the data and detected the unmistakable pulses of radiation.

The first surprise was the pulsar's extraordinarily rapid spin, the fastest of any pulsar known. Although all pulsars rotate rapidly, this one spins 1,968.629 times a second, which is very close to the limit at which it can spin without being torn apart. For comparison, the second-fastest pulsar spins less than one third as fast.

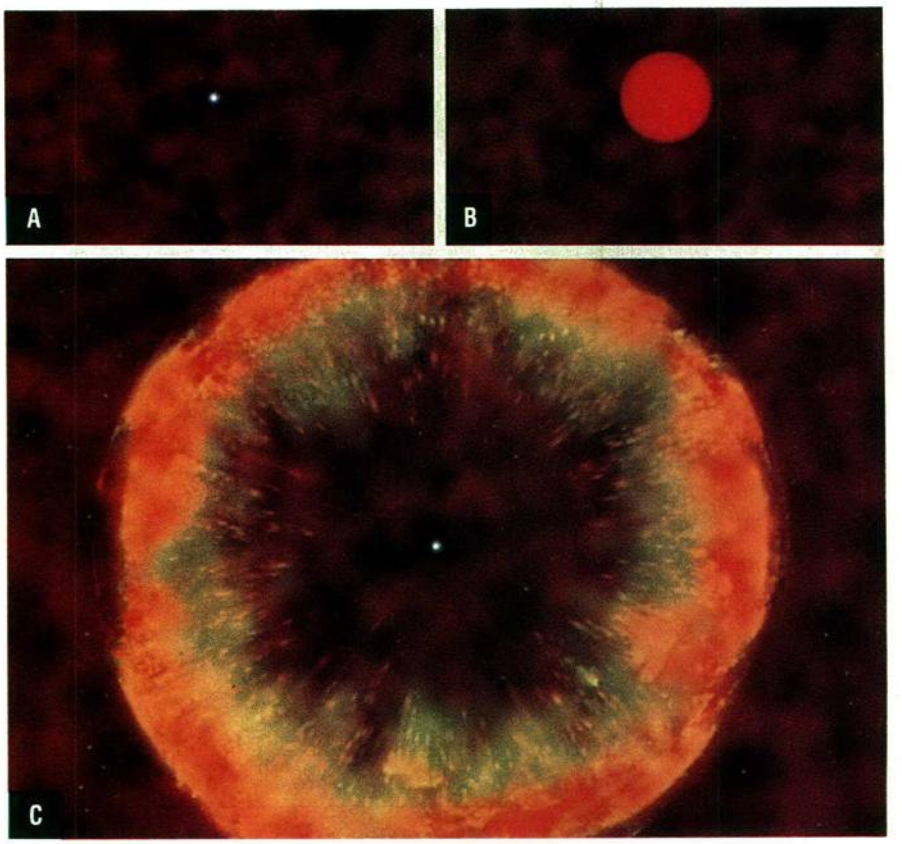
But all of the millisecond pulsars discovered so far appear to be old objects that belong to binary systems where the pulsar has been "spun up" by material accreting from a companion star. Until this discovery the fastest pulsar directly associated with a supernova was the pulsar in the Crab Nebula, which spins only thirty times a second.

The pulsar's rapid spin points up another theoretical problem. A pulsar's luminosity grows with the strength of its magnetic field and with its rate of rotation. The group's observations show the pulsar is fairly faint: its magnitude varies between 18 and 19. When combined with the huge spin rate, the low luminosity implies that the magnetic field is quite weak — only about one thousandth as strong as theory predicts.

But the most puzzling aspect of the pulsar's behavior is the small but regular variation in the rotation rate that occurs with an 8-hour period. The simplest explanation for the variation is a companion object orbiting the pulsar. If true, the companion has the mass of Jupiter and is as far from the pulsar as Earth is from the Sun. This would have put it inside the outer layers of the star before it exploded!

No one has yet been able to satisfactorily explain this new data. If the companion existed before the supernova, it's hard to imagine how it survived the explosion. On the other hand, if it arose after the supernova, where did it come from? One possibility is that the core of the collapsing star was spinning so rapidly that it split into two pieces.

The most important question raised by the discovery of the 1987A pulsar is whether the pulsar is a freak of nature or whether its bizarre properties are common in newborn pulsars. Until now astronomers could only look at thousand-year-old pulsars, like the Crab pulsar, and try to extrapolate their behavior backward into infancy. Continuing observations of the two-year-old 1987A pulsar should tell astronomers if that technique was valid.



STELLAR REJUVENATION is the only explanation so far for a small cloud of gas observed around the white dwarf 0950 +139. This artist's conception traces the life of the star from a white dwarf (A), through its brief revival as a red giant (B), to a white dwarf surrounded by a shell of newly ejected matter (C). The red mottling in each picture is the old gas shell, ejected 50,000 years ago.

'BORN-AGAIN' RED GIANT BAFFLES ASTRONOMERS

As with organic life, the birth, life, and death of stars are considered a one-way journey by astronomers. However, the discovery of a white dwarf that may have briefly reignited its nuclear fusion processes — in essence come back to life after death — may force astronomers to modify their understanding of how stars finish out their lives.

The discovery was made by Howard E. Bond of the Space Telescope Science Institute, James Liebert and Thomas Fleming of the University of Arizona, Richard

Take Any 3 Books for only $1.00 Each!

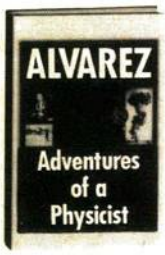
as your introduction to the

Astronomy Book Club.

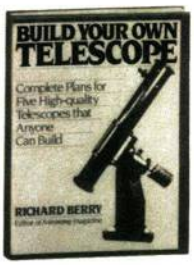
You simply agree to buy 3 more books—at handsome discounts—within the next 12 months.

Values to $74.85

(Publishers' Prices shown)

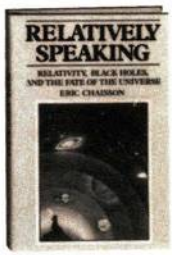


32640 $19.95

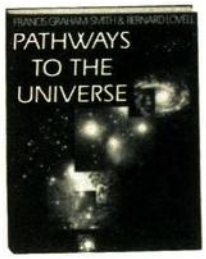


36988 $24.95

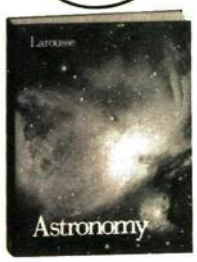
47250 $14.95



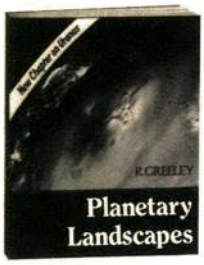
73836 $18.95



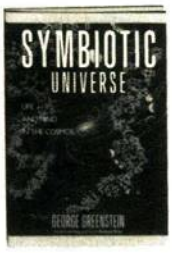
67222 $24.95



57765-2 $35.00
(Counts as 2 choices)

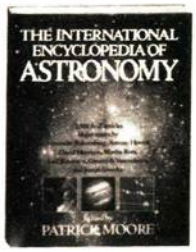


69377-2 $29.95
(Counts as 2 choices)



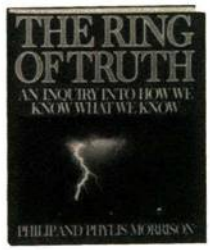
81662 $18.95

65260 $24.95

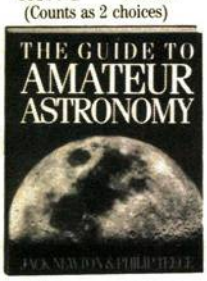


55915-2 $40.00
(Counts as 2 choices)

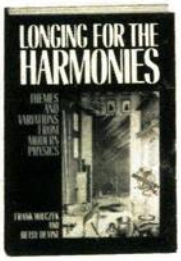
61356 $19.95



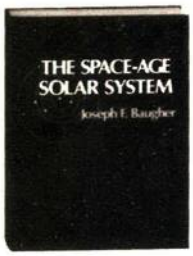
74202 $24.95



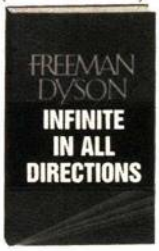
51805 $24.95



58858 $19.95

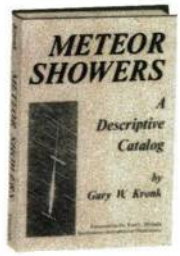


46316-2 $33.45
(Counts as 2 choices)

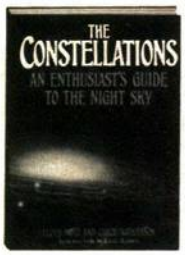


55344 $19.95

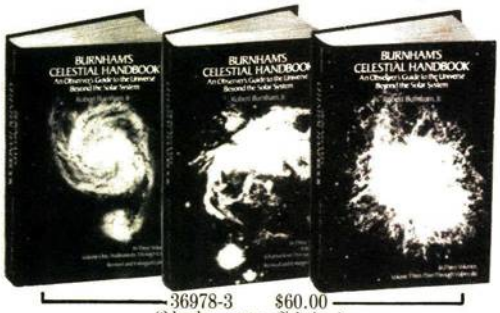
64174 $23.95



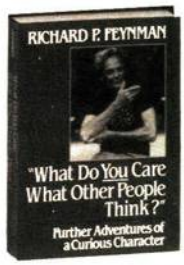
62456 $24.50



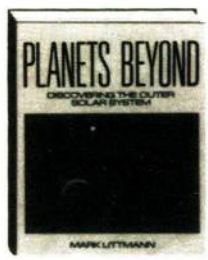
40139 $24.95



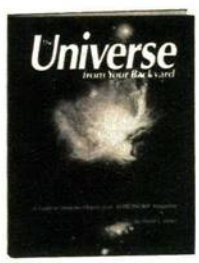
36978-3 $60.00
(3 books count as 3 choices)



86670 $17.95



69292 $22.95



85353 $24.95

MEMBERSHIP BENEFITS • In addition to getting three books for only $1.00 each when you join, you keep saving substantially on the books you buy. • Also, you will immediately become eligible to participate in our Bonus Book Plan, with savings of 65% off the publishers' prices. • At 3–4 week intervals (16 times per year), you will receive the Astronomy Book Club News, describing the coming Main Selection and Alternate Selections, together with a dated reply card. • If you want the Main Selection, do nothing, and it will be sent to you automatically. • If you prefer another selection, or no book at all, simply indicate your choice on the card and return it by the date specified. • You will have at least 10 days to decide. If, because of late mail delivery of the News, you should receive a book you do not want, we guarantee return postage.

© 1989 Macmillan Book Clubs, Inc.

Astronomy Book Club
Riverside, New Jersey 08075

Please accept my application for trial membership and send me the three volumes indicated, billing me only $1.00 each, plus shipping and handling. I agree to purchase at least three additional Selections or Alternates over the next 12 months. Savings range up to 30% and occasionally even more. My membership is cancelable any time after I buy these three additional books. A shipping and handling charge is added to all shipments.

No-Risk Guarantee: If I am not satisfied—for any reason—I may return my introductory books within 10 days. My membership will be canceled, and I will owe nothing.

A few expensive books (as noted) count as more than one choice.

3 books for $1.00 each:
Indicate by number the books you want.

Name_____

Address_____ Apt.____

City_____

State_____ Zip_____

(Books purchased for professional purposes may be a tax-deductible expense. Offer good in Continental U.S. and Canada only. Prices slightly higher in Canada.)

Astronomy 5/89 L-CJ6

Green of Kitt Peak National Observatory, Jay B. Holberg and Ken Kidder of the Lunar and Planetary Laboratory, and Francois Wesemael of the University of Montreal. The group presented their findings at last January's meeting of the American Astronomical Society in Boston.

The white dwarf star, cataloged as 0950 +139, lies at the center of a large, faint nebula called EGB 6 in the constellation Leo. The nebula formed an estimated 50,000 years ago when the star was a red giant, one of the final stages in a star's life. Once a red giant exhausts its nuclear fuel, the core contracts and becomes a white dwarf. The outer atmosphere, however, continues to expand from the white dwarf and is observed as a nebulous shell surrounding the star. Such nebulae are called planetary nebulae because of their disklike shapes; the Ring Nebula in the constellation Lyra is an example.

Astronomers believe the white dwarf stage marks the end of a star's life. Other than a gradual cooling period, which lasts for billions of years, no further stellar activity is expected.

Spectroscopic observations of 0950 +139, however, detected strong emission lines of hydrogen, helium, doubly ionized oxygen, and doubly ionized neon that do not arise from the old, faint shell but are confined to a smaller, unresolved nebular core around the star. The inner nebula has roughly the diameter of our solar system and is evidently a recently shed mantle of gas.

"A spectrum like this, with unmistakable signs of a surrounding gas cloud, has never been seen before in such a highly evolved star," said Bond. "My coworkers and I believe the gas indicates that the star has very recently undergone additional mass loss." Such behavior, Bond added, "is unexpected once a star has become a white dwarf, because of the tremendous gravitational force at the surface of a white dwarf."

One possibility is that nuclear fusion processes were somehow reignited below the white dwarf's surface, which caused it to briefly balloon back into a red giant. Recent theoretical studies by Icko Iben of the University of Illinois and James MacDonald of the University of Delaware suggest that hydrogen may diffuse below the white dwarf's surface to mix with carbon rising up from the star's interior, leading to reignition.

"This rebirth as a 'born-again' red giant may only have lasted for a few years and could well have gone unnoticed by astronomers," said Bond. Then, after its brief revival, the star recollapsed into the white dwarf while its outer layers formed the new shell observed today.

ACID GROUNDWATER ON MARS

The Valles Marineris region on Mars contains, apart from its gigantic canyons, many enclosed depressions that lack a drainage outlet and for which a classical erosion or tectonic origin doesn't seem to apply. John Spencer, Fraser Fanale, and Jane Tribble of the University of Hawaii think these depressions may have been created when sulphuric acid in groundwater dissolved carbonate rocks at the surface.

On Earth, carbonate rocks such as limestone are dissolved by carbonic acid in groundwater. The resulting terrain, full of caverns and sinkholes, is called karst, after the region in Yugoslavia where it was first described.

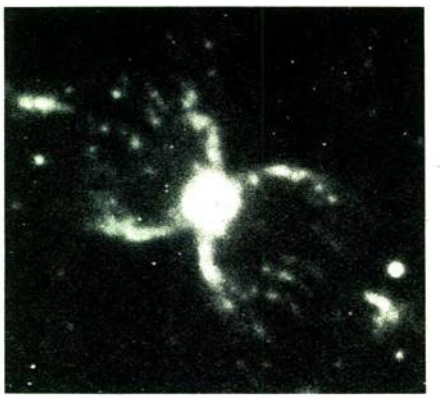
Spencer and his colleagues, however, focused on sulphur as the active ingredient to produce karst on Mars rather than carbon dioxide, because under Martian conditions not enough CO_2 can reside in the groundwater to create the observed effects. (Carbonic acid is also relatively weak and requires an abundant water supply, such as on Earth, to produce karst terrain.) Melting of ground ice, which some scientists suspect has caused "collapsed terrain" on Mars, was also rejected because its effects would look more glacierlike than what is observed.

On the other hand, the researchers note, *Viking* soil samples were rich in sulphur, presumably from volcanic activity. If this sulphur were mixed into groundwater, it would produce sulphuric acid that could attack the rocks, starting along fault lines and other places where the rocks were weaker. Another possibility is hydrochloric acid, because *Viking* samples showed a slight enrichment of chlorides in the soil as well. The result in either case could be a Martian form of karst with closed depressions replacing the sinkholes found on Earth.

'SOUTHERN CRAB' MAY BE A PROTO-PLANETARY NEBULA

A strange, crab-shaped nebula in the southern constellation Centaurus may be a star on its way to becoming a planetary nebula. The 14.6-magnitude object, cataloged as He 2-104, has been dubbed the "Southern Crab" to differentiate it from the Crab Nebula supernova remnant.

Astronomers Hugo Schwarz of the European Southern Observatory, Colin Aspin of the United Kingdom Joint Astronomy Centre, and Julie Lutz of Washington State University discovered the nebula with the ESO 2.2-meter telescope at La Silla, Chile. The object



A REALISTIC "CRAB" NEBULA, located in the constellation Centaurus, appears to be a planetary nebula in the making.

appears to be a dust-enshrouded symbiotic star — a binary system consisting of a small hot star and a red giant — where the hot star is rapidly evolving from a normal star into a planetary nebula.

The astronomers attribute the crablike appearance of He 2-104 to a rapid stellar wind that blows from the central, hotter star and collides with the surrounding interstellar medium. The wind, which consists largely of energetic atoms and ions, is blocked from blowing in the star's equatorial plane by a disk of gas and dust transferred from the red giant to the central star. The wind escapes in the polar directions instead, which gives rise to the two "bubbles" that form the legs of the crab. The bubbles appear brighter at the edges because we are looking through more material there than at their centers.

The two blobs seen in the same general direction as the bubbles but farther from the object's center arise from an even faster stellar wind, blowing over 100 kilometers per second. Both the legs and blobs are regions of interstellar gas and dust that have been heated rapidly by their collision with the stellar wind, which causes them to glow.

MARS' OCEANS OF YESTERYEAR?

How much water did Mars have billions of years ago? This question sounds hopelessly insolvable, but a quirk of nuclear chemistry provides an opening through which researchers today can extract an answer. Astronomers Gordon Bjoraker and Michael Mumma of NASA's Goddard Space Flight Center and Harold Larson of the University of Arizona used this quirk to arrive at an estimate of how much water has left Mars over the past 4.5 billion years.

We're committed to Quality & Service

Our company has always been committed to providing our customers with the best that we can offer. When you call our sales consultants they listen to your questions, then make a recommendation of the best possible equipment to fit your needs.

It can be very difficult to choose the right telescope or accessory. Northern Sky Telescopes is there to help make that choice an exciting and pleasant experience. You may be confident that we are also there after the purchase with helpful hints and service. This is our committment to you.

Don Colone

Meade 2080 LX-5

This 8" Schmidt-Cassegrain telescope offers simplicity for visual and astrophotographic enjoyment. Included as standard equipment with this telescope are over 30 different features and accessories, making this package an outstanding value among 8" Schmidt-Cassegrain telescopes.

$1579

Meade 2120 LX-5

The 10" version is 56% brighter than the 8" model. This instrument will offer the viewer greater detail of the stars and galaxies. You will be astounded by the clarity of the whirlpool galaxy and other splendors of the sky.

$1969

Meade 2080 LX-6

This unique 8" Schmidt-Cassegrain telescope with an f/6.3 focal ratio offers tremendous advantages over the f/10 system. A 59% wider field of view provides more than twice as many stars visually. A 60% reduction in astrophotography exposure times allows more photos with less time for mistakes.

$1895

Meade 2120 LX-6

This telescope has been designed to be the ultimate astrophotographic tool. The unique combination of the f/6.3 system and the 10" Schmidt-Cassegrain will make successful astrophotography easier than it has ever been before. Imagine, the perfect Orion Nebula in only 15 minutes.

$2489

Accessories

We have noticed that certain accessories seem more popular than others therefore we have listed the 12 most asked for accessories:

1) #712 Dew Shield (8") $59
2) #710 Dew Shield (10").....$89
3) #39 Declination System.....$99
4) #1200A Motorized Focuser $169
5) #1401 Tube Balance Wt.(8").....$99
6) #1402 Tube Balance Wt.(10").....$99
7) Telecompressor System $69
8) Tripod Carrying Bag $89
9) #62 T-Adapter $39
10) Off-Axis Guider System.....$159
11) Deluxe Accessory Case $89
12) Tele-Extender $39

Call Toll Free
1-800-345-4202

or (612) 545-6786
Fax: (612) 545-9297

Meade Series 4000 Eyepieces

The optical glass of the Meade 4000 eyepieces has been designed to provide a high resolution image for maximum clarity and contrast.

Super Plossl

6.4mm, 9.7mm, 12.4mm $75
15mm, 20mm, 26mm $75
32mm or 40mm $99
56mm $169
#140 Barlow $69

Super Wide Angle

13.8mm $119
18mm $129
24.5mm $139
32mm $199
40mm $249

Ultra Wide Angle

4.7mm $139
6.7mm $149
8.8mm $198
14mm $219

Meade Newtonian Telescopes

Meade 826C

An 8" telescope with all of the features that this model has to offer should cost a great deal more. Let's not tell Meade.

$889

Meade DS-10A

This telescope offers a tremendous diameter without costing a fortune. An excellent value. **$899**

Meade DS-16A

There is no other telescope made today that has as much to offer as the DS-16A at this price. This instrument will give you such magnificent detail and clarity that you won't believe your eyes. I have viewed the veil nebula through the DS-16A and have found very few telescopes can compare to the impressive image I saw that night.

$1789

We take pride in our service.
Trade-ins accepted
Store Hrs: M-F 9-6 Sat 10-5
Phone Hrs: M-F 9-8 Sat 10-5

VISA MasterCard DISCOVER

NORTHERN SKY TELESCOPES

Northern Sky Telescopes

5667 Duluth Street
Golden Valley, MN 55422

'Specialists in Telescopes, Binoculars & Accessories'

The trick lies in the fact that mixed among every 10,000 atoms of ordinary hydrogen on Earth is one atom of heavy hydrogen, or deuterium. When ultraviolet light from the Sun hits ordinary water (H_2O) exposed at Mars' surface, it breaks the molecule apart and the hydrogen escapes into space. When sunlight breaks up water made with deuterium (HDO), the hydrogen escapes but deuterium, being heavier, tends to linger around. Over time, therefore, the proportion of deuterium grows steadily greater. If vast quantities of Martian water have been destroyed, the amount of deuterium present there now should be enriched.

Bjoraker, Mumma, and Larson observed Mars' infrared spectrum from aboard the Kuiper Airborne Observatory to compare Mars' amount of H_2O to HDO. They found that on Mars, deuterium was a little over five times more plentiful than it is on Earth.

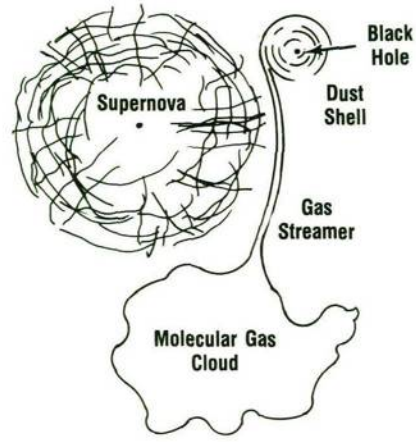
This finding agrees with theories that call for a denser atmosphere early in Mars' history than today, but it does not say how dense that atmosphere may have been. It does tell us, however, that Mars has lost enough water since its formation to cover the whole planet to a depth of at least eight inches — and possibly as much as several dozen feet. This figure is not as high as the 1,500 feet some geologists have proposed, but without getting a better inventory of Mars' present water resources and perhaps surface and subsurface samples, the question of Mars' "water history" will remain an unsolved problem.

GAS STREAMER MAY FEED GALACTIC CENTER

A stream of gas 15 light-years long may be feeding a dusty gaseous shell surrounding the center of the Milky Way, 30,000 light-years away. Recent spectroscopic observations indicate that the shell may be rotating around a 1 million solar mass black hole, which may be drawing parts of the shell toward it.

Paul Ho, an astrophysicist at the Harvard-Smithsonian Center for Astrophysics, announced the discovery at January's meeting of the American Astronomical Society in Boston. Ho, along with colleagues from the Max Planck Institute in Munich, the University of Cologne, and the Massachusetts Institute of Technology, discovered the gas streamer using the Very Large Array.

The observations indicate that the gas streamer is being drawn from a nearby giant molecular cloud, which may serve as a reservoir of matter to fuel the black hole. Gas flows from the molecular cloud along the streamer and into the shell, which lies within 6 to 10 light-years of the galactic center. Ho said kinks in the streamer may be the result of shock waves from nearby supernova explosions. The shocks may loosen the gas from the molecular cloud and funnel it toward the galactic center.



SUPERNOVA SHOCK WAVES may have pushed gas from a molecular cloud into a black hole at the center of our Galaxy.

Ho said that the discovery may be the best opportunity for studying how matter falls into a massive black hole or galactic nucleus. "It is exciting because it would be the closest example that we could study with very high angular resolution," he explained. The observations are possible, he added, with existing major telescopes and those under construction or planned.

ERODING THE MARTIAN ATMOSPHERE

Big impacts wreak havoc on planetary landscapes, gouging out basins and throwing surface materials in all directions. But impacts can also affect the atmosphere of a planet, even to the point of removing much of it. Jay Melosh and Ann Vickery of the University of Arizona studied what would have happened to Mars' atmosphere 4 billion years ago, when large impacts were common.

Out of their computer calculations emerged a useful rule of thumb. When the object strikes with a velocity of at least 12 kilometers per second *and* has more mass than all the atmosphere lying above a plane tangent to the planet's surface at the impact point, the explosion following the impact will strip off all the atmosphere above the tangent plane. This means that many big impacts can quickly blow off large amounts of atmosphere.

The result, Melosh and Vickery note, is that early in its history, Mars' atmosphere would have undergone severe erosion over a geologically short time. Only the sharp decline in impacting objects beginning about 3.8 billion years ago would have stopped the erosion. At that point, Mars' atmosphere, which had begun with a surface pressure about as great as Earth's, was reduced to roughly 2 percent of Earth's surface pressure.

PUT THE VLA ON A POSTAGE STAMP

The National Radio Astronomy Observatory is proposing that the Very Large Array radio telescope be commemorated with a postage stamp in the early 1990s. The Very Large Array (VLA), located in Socorro, New Mexico, is the world's largest radio telescope and has been fully operational since 1981. The stamp would pay tribute to the VLA's decade of scientific accomplishments.

For a stamp to be issued by the U.S. Postal Service, the Citizens Stamp Advisory Committee must be convinced that there is strong public support for such a stamp. Letters in support of a VLA stamp should be sent to: Citizens Stamp Advisory Committee, Stamp Information Branch, 475 L'Enfant Plaza, Washington, DC 20260.

ASTEROID NAMED FOR ASP'S HUNDREDTH ANNIVERSARY

An asteroid has been named "ASP" in honor of the one hundredth anniversary of the Astronomical Society of the Pacific, the first national astronomy society in the United States. The asteroid was discovered in 1959 in a search led by Frank Edmondson, an ASP member for fifty-four years who proposed "ASP" as the name for one of the asteroids his team found.

The announcement of the newly named asteroid kicks off a year of centennial celebrations for the ASP, an international scientific and educational organization composed of professional and amateur astronomers. The ASP was founded in 1889 by Edward Holden, the first director of Lick Observatory, and Charles Burckhalter, a science teacher, after a cooperative professional-amateur eclipse venture.

The ASP is also actively involved with astronomy education. It sponsors teacher workshops and publishes a newsletter for teachers. The ASP's annual meeting will be held at the University of California at Berkeley this year on June 21-25.

Paramount Pictures Corporation

Presents

THE STARSHIP ENTERPRISE™

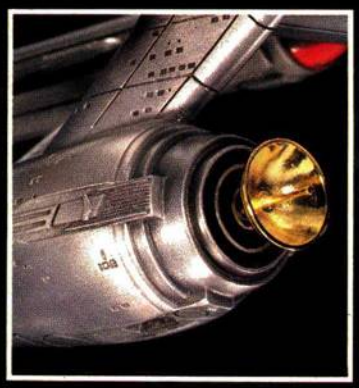
TO BOLDLY GO WHERE NO ONE HAS GONE BEFORE.™

Aglow with 24-karat gold electroplate and sparkling with crystals, the Starship *Enterprise* is shown smaller than actual size of approximately 10" in length.

The first pewter re-creation ever authorized by Paramount Pictures of the most famous Starship of all time.

The Starship *Enterprise*.™ Symbol of the eternal quest to explore new worlds.

Now, the Starship that carried Kirk, Spock and Uhura to the far reaches of the Galaxy can be yours. Announcing the first fully authorized pewter re-creation of the Starship that has inspired millions.



Precisely reproduced with assistance from STAR TREK® creator Gene Roddenberry.

Sculptured and handcrafted in fine hand-finished pewter. The main sensor and navigational deflector glow with 24-karat gold electroplate. The top propulsion units blaze with fiery red crystal cabochons.

Available only on planet Earth, and only from The Franklin Mint.

Priced at $195.

AUTHORIZED BY PARAMOUNT PICTURES.

AUTHENTICATED BY GENE RODDENBERRY.

ORDER FORM

The Franklin Mint
Franklin Center, Pennsylvania 19091

Yes, I want to take advantage of the unprecedented opportunity from Paramount Pictures to acquire the only authorized and fully authenticated pewter replica of the Starship *Enterprise*.™ The reproduction is hand-cast in fine imported pewter, hand-chased and hand-rubbed to a classic patina, accented with crystals and 24-karat gold.

I need send no money now. I will be billed for my deposit of $39.* prior to shipment and then in 4 equal monthly installments of $39.* each, after shipment.

*Plus my state sales tax and a total of $3. for shipping and handling.

Paramount
A Gulf + Western Company
Officially Licensed Product

© 1989 Paramount Pictures Corporation. All Rights Reserved. STAR TREK, The U.S.S. *Enterprise*, and "To Boldly Go Where No One Has Gone Before" are Trademarks of Paramount Pictures Corporation.

Please mail by May 31, 1989.

Signature _____
ALL ORDERS ARE SUBJECT TO ACCEPTANCE.

Mr./Mrs./Miss _____
PLEASE PRINT CLEARLY.

Address _____

City, State, Zip _____

12135-2

Each replica of the Starship *Enterprise* is accompanied by a Certificate of Authenticity with Gene Roddenberry's signature.

THE BEST GETS BETTER. Introd

Celestron is pleased to introduce the finest 8″ Schmidt-Cassegrain telescope in the world. The design features in the Ultima 8 are the most advanced offerings incorporated into a single new model telescope at one time.

UNSURPASSED OPTICAL EXCELLENCE

The world has long recognized Celestron's reputation of producing the finest, most precise optical system on the market.

The Ultima's properly baffled 8″ aperture, 2032mm focal length, f/10 Schmidt-Cassegrain optical system is simply the best you can buy. Each of the three key optical elements is individually hand corrected to perfection by an optical specialist to meet our exacting 1/10th wave system specification.

The Ultima comes with the well-known Starbright® optical coatings group. These proprietary multi-coatings on all air/glass surfaces produce the brightest image available of any 8″ Schmidt-Cassegrain scope.

No other manufacturer of Schmidt-Cassegrain scopes can compare to the rigid optical fabrication, testing and quality control standards applied at Celestron to the Ultima.

LARGER FORK TINES

PRECISION OPTICS

ucing The Ultima 8

MECHANICAL AND STRUCTURAL STABILITY

Celestron has employed new larger, more rigid castings for the fork tines (about twice the size of competitive units), drive base, polar shaft (integral to the casting) and rear cell to make the Ultima 8 incredibly stable. The newly improved tripod with rubber coated legs and heavy duty wedge have also been designed with stabilizing features for rock solid viewing and astrophotography.

CORDLESS ELECTRONIC DRIVE

The Ultima 8 features a *Quartz-Locked* accurate and easy-to-use electronic drive system which is totally *cordless*—no separate power requirements or myriad of wires to contend with. The state-of-the-art electronics in the base include built-in, sealed, rechargeable lead acid batteries providing a full night's operation on a single charge.

The base's electronic system already includes the essential drive corrector elements for advanced astrophotography—you only need to add a simple hand controller.

ULTRA-ACCURATE DRIVE GEAR SYSTEM

The Celestron/Byers large ultra-accurate 359 tooth worm gear drive system is recognized world-wide as the most accurate system offered on any commercial fork-mounted telescope.

CORDLESS DRIVE

ERGONOMIC USER-FRIENDLY OPERATION

The Ultima has been engineered to be accessible to the beginner but with sophisticated technical features and innovations that will excite serious amateurs. Convenient carrying handles on the fork and rear cell make it safe and easy to handle. A deluxe foam-fitted carrying case is supplied so that everything you need fits inside.

QUALITY STANDARD ACCESSORIES

The Ultima is supplied with a wide angle, bright image, 30mm Multi-Coated 1¼″ Plossl eyepiece as well as a high power 7mm Orthoscopic ocular. The star diagonal is a Multi-Coated 1¼″ prism type. The Ultima also has a finder which can be used either in the right angle or straight through mode. The large 8 × 50 finder also has an illuminated polar alignment reticle and an extra large 5.2 degree field of view ideally suited to help you find dim objects with ease. When compared to other 8″ scopes, the superiority of the increased size Dec and RA circles is huge.

The Ultima is covered by Celestron's limited lifetime warranty.

See the Ultima 8 at your Celestron dealer today.

DELUXE CASE

BY POPULAR DEMAND, CELESTRON REINTRODUCES THE CLASSIC C8.

For the economy buyer who wants optical excellence, yet doesn't require a lot of extras, the Classic 8 is the perfect choice.

The Classic 8 offers the same optical quality as the Ultima 8 (Starbright® Coating Group is an option).

The Classic 8 runs off of AC power. Its clock drive utilizes an improved spur gear drive system which is as good or better than competitive worm gear systems.

The Classic 8 comes with a 25mm Kellner 1¼″ ocular, 1¼″ prism star diagonal and a 6 × 30 straight finderscope.

For those on a modest budget, but with a desire for a superior quality telescope, the Classic 8 is it.

Call 1-800-421-1526 for a free color brochure for details on the extensive array of optional accessories available as well as more information on the features of the Ultima 8 and the Classic 8.

CELESTRON®

Celestron International
P.O. Box 3578, 2835 Columbia Street
Torrance, CA 90503 (213) 328-9560
Toll-Free 1-800-421-1526 (Continental USA)

Space News

SATELLITES ON A STRING

A unique satellite will be carried aboard the space shuttle in the next decade. Instead of being released to float free in its own orbit, this satellite will remain attached to the shuttle on a cable up to 60 miles long. Called the Tethered Satellite System, this satellite offers new opportunities for studying Earth's ionosphere and the upper reaches of the atmosphere. NASA has scheduled three tethered satellite missions, with the first being carried aboard the space shuttle *Atlantis* in January 1991.

Tethered satellites have engendered considerable interest within the scientific community. The Third International Conference on Tethers in Space is being held this month in San Francisco to examine the research potential of this new orbital technology.

The tethered satellite project is a multinational undertaking. The Italian Space Agency is building the satellite and NASA is supplying the tether and the equipment for deploying the satellite. The tether is being assembled this summer by the Martin Marietta Corporation, NASA's contractor for the project.

The satellite, which will be used on all three missions, is an aluminum sphere 5.3 feet in diameter that weighs 1,100 pounds. Science instruments and sensors will be carried in the upper half of the satellite and on the outside suspended from booms. The bottom half of the satellite will contain control thrusters and radio equipment.

The project wouldn't be possible without a special tether that is very strong yet very light. A multilayered, braided Kevlar cable one sixteenth of an inch in diameter was selected for this project. Weighing only 4 pounds per mile, the cable has a breaking point of 650 pounds.

The tether keeps the satellite moving with the shuttle by countering the effects of gravity that cause an object in a lower orbit to circle Earth faster than one in a higher orbit. As the satellite is reeled upward, gravity has a greater effect on the shuttle than on the satellite, forcing it to move faster than the satellite, which is farther from Earth. The tether, however, effectively increases the velocity of the satellite, thus keeping them traveling together.

On the first mission the satellite will be reeled upward 12.4 miles. After being deployed for 20 hours, the satellite will be reeled back in to the shuttle's payload bay. By the third mission, tentatively planned for October 1994, the satellite will be reeled upward 62 miles. During these two missions the satellite will carry two booms that will expose several instruments to charged particles that flow past. Sensors will collect data about the plasma that makes up the ionosphere.

In addition, an electrical current will be sent through the tether to learn how the ionosphere interacts with large, electrically active bodies. This will allow scientists to model the interaction that takes place between Jupiter's magnetosphere and its moons, according to Mario Grossi, who came up with the idea for a tethered satellite project in the early 1970s. A staff scientist at the Harvard-Smithsonian Center for Astrophysics, Grossi believes

THE SPACE SHUTTLE will deploy and retrieve scientific instruments attached to a lightweight tether beginning in January 1991.

that this research "will give us a better understanding of what is going on around Jupiter."

Tethered satellites are also being investigated for other astronomical applications. George Corso of Loyola University of Chicago has proposed using the satellites to collect cosmic dust. A satellite with passive impact collectors mounted on the outside could be reeled downward from the shuttle to collect cosmic dust particles in the upper atmosphere before they get low enough to mix with terrestrial particles. Corso also suggests that tethers would be a good way to regularly sample the build-up of manmade space debris in low Earth orbit. — *Robert G. Nichols*

PHOBOS 2 REACHES MARS, SOME PROBLEMS REPORTED

The Soviet Union's *Phobos 2* spacecraft arrived at Mars in the last week of January, two hundred days after leaving Earth. But the *Phobos* spacecraft, one of which did not make it to Mars because of a programming error, continue to experience worrisome technical problems. Despite the problems, Soviet officials are confident that the program will still produce startling new information about the Red Planet and its satellites and pave the way for future manned missions.

During *Phobos 2*'s voyage to Mars, several subsystems aboard the spacecraft failed, although most were eventually repaired. One system that has not been revived is the spacecraft's main 50-watt antenna. With this system down, *Phobos 2* will have to rely on a back-up 5-watt antenna that transmits at a slower rate.

In January the Soviets announced problems with the television system on *Phobos 2*. In addition to providing images of Mars and Phobos, the video system will be used to maneuver the spacecraft close to Phobos.

The condition of the "hopper" and lander instruments that *Phobos 2* will drop onto the surface of Phobos will not be known until the probes are powered up just prior to the encounter. One instrument will hop across the surface of Phobos while the other will anchor itself to the surface of the moon and operate for up to a year. The Phobos encounter is expected to occur in April.

In spite of these problems most of the experiments and observations will be conducted as planned. However, *Phobos 2* has "limited onboard data storage capacity," according to Soviet spaceflight expert, James E. Oberg, so careful scheduling will be necessary to prevent the loss of valuable data. — *Robert G. Nichols*

HEXADOME

THE AFFORDABLE OBSERVATORY

Over 7 ft. overall height. *Inside diameter 82 in.*

Dome will turn full 360°.

KINARD MANUFACTURING CO.
P. O. Box 971
Hillsboro, TX 76645
(817) 582-8154

Visa
MasterCard

Send $1 for brochure.

$895 PLUS TAX & FREIGHT

$695 if you build the base.
Hardware & instructions furnished.

THE SKY IS NOT THE LIMIT WITH FUJINON.

Fujinon is better by far. Every computer-designed, optical surface is electron beam coated (EBC) with zirconium oxide. 99.9% of the light striking any surface passes through. More important, 95% of the light entering the objective lenses emerges from the ocular lenses. And each model meets U.S. military specifications for strength, shock and temperature resistance, and for being waterproof.

The new F-series (7 × 50 FMT-SX and 10 × 70 FMT-SX) gives the ultimate in brightness and resolution. With flat-field optics, tangential and sagittal astigmatism and distortion are reduced to levels the eye can't detect. From center to edge, the image is perfect. For improved color correction, objective lenses have a shorter focal length. Eyepieces, with 27mm ocular lenses, are comprised of 4 groups — 5 elements. With 23mm eye-relief — the world's longest — you see a full image even when wearing glasses.

In addition to Fujinon's patented EBC coating, inside the light alloy housings, surfaces are ribbed and finished in matte black. Lens and prism edges are carbon black-coated to further reduce reflections. Optional accessories include: tripod adapter, Nebura filters, vision correcting diopter attachments and haze, polarizing, and neutral density filters.

Fujinon's 25 × 150 MM Astronomical Binocular — The world's most powerful. The same binocular, with conventional instead of right-angle viewing, is used by the U.S. Navy and Coast Guard. Exit pupil: 6mm; brightness factor: 36; field of view: 2°42"; weight: 64 lbs. Suggested list: $11,000.00 including pedestal for permanent installation.

For more information, a free color catalog and the name of your nearest dealer, please contact us. If there is no dealer near you, order directly — with 10 day free trial. Major credit cards and certified checks accepted.

FUJINON

FUJINON INC.

10 High Point Drive, Wayne, N.J. 07470
(201) 633-5600 Dealer Inquiries Invited
A Subsidiary of Fuji Photo Optical Co., Ltd.

Amateur News

CLEAR SKIES FOR WINTER STAR PARTY

Four clear nights graced the fifth annual Winter Star Party on February 2 through 5, 1989. Sponsored by the Southern Cross Astronomical Society of Miami, the star party this year attracted 320 amateur astronomers to Camp Sawyer on Spanish Harbor Key in the Florida Keys.

The primary activity at the star party was deep-sky observing. There were over 130 telescopes at the site, including a 25-inch Dobsonian, four 20-inch telescopes, one 18-incher, and at least half-a-dozen 17.5-inchers — not to mention several dozen in the 10- to 16-inch range. The large number of altazimuth telescopes prompted the observers to nickname the aperture-filled field beside star party chairman Tippy D'Auria's trailer the "Valley of the Dobs."

The low latitude of the site (24.5°) and comfortable nighttime temperatures (in the seventies) made observing southern sky objects sheer pleasure. Visible were the Southern Cross, the Eta Carinae Nebula, and Omega Centauri. Northern observers visiting the Winter Star Party saw familiar cold-weather objects such as the Orion Nebula high in the sky and Jupiter near the zenith.

Particularly impressive was viewing parts of the Gum Nebula — a supernova remnant at declination −44° — with a 20-inch Dobsonian. The nebulosity spread across at least 4°, so I had to scan the telescope to see all of it.

Many observers thrilled to looks through Tom and Jeannie Clark's 25-inch f/5 Dobsonian. Under the dark and steady Florida skies the Orion Nebula was beyond description. The fifth and sixth stars in the Trapezium — tough objects where the seeing is poor — were bright and obvious. The nebula itself, showing the palest tints of red and green, was breathtakingly detailed at 600x.

Tom Lorenzin, author of *1000+*, went from telescope to telescope pointing out especially interesting but little-known nebulae. On his recommendation, I viewed NGC 1999, a beautiful little nebula south of the Orion Nebula. Lorenzin based the list of 1,100 deep-sky objects given in his book on objects he had observed and found appealing.

I found myself agreeing with Jack Newton's assessment that Tippy and Pat D'Auria's 18-inch was, in Jack's words, "the finest Dob I've ever seen for star images." In this telescope Jupiter's clouds broke into countless fine features, and the disks of the satellites were readily visible. Even Mars, only 7" in diameter, showed some surface features.

One outstanding quality of the star party was tight control of light. After dark, star party rules prohibited shining white lights of any kind. This allowed observers' eyes to become fully dark adapted. Although the Riverside Telescope Maker's Conference and Stellafane also have "no lights" policies, these rules are too often ignored.

The Winter Star Party's lecture program, held in the afternoons, featured talks on astrophotography by Jack Newton, the recent apparition of Mars by ASTRONOMY contributors Don Parker and Jeff Beish, variable star observing by Janet Mattei of the American Association of Variable Star Observers, and occultations by Mike Reynolds.

Daytime activities in the Keys included snorkeling and scuba diving on nearby reefs, fishing and boating in the Straits of Florida, swimming at Bahia Honda State Recreation Area, hiking at the Key Deer Wildlife Refuge, and birding in the Everglades. — *Richard Berry*

PALM TREES AND TELESCOPES came together at the Winter Star Party last February. Background stars are those of Vela, Puppis, and Carina. Photo by Richard Berry.

NORTH AMERICAN NOCTILUCENT CLOUD NETWORK FORMED

In an effort to learn more about noctilucent clouds, Canadian observer Mark Zalcik has started an organization to coordinate observations of these mysterious clouds in North America. In 1988, its first year of operation, the network collected observations from approximately fifty people, which Zalcik has used to try to better understand the clouds' frequency, distribution, and yearly appearances.

Noctilucent clouds occur high in Earth's atmosphere and are illuminated by sunlight when the Sun is between 6° and 16° below the horizon. (See "Clouds of the Twilight" by David McConnell, July 1987.) The peak time to observe them is during the summer months and especially around the time of the summer solstice. They are most often seen from high-latitude locations and are very rare at latitudes below 45° or above 75°.

The group of fledgling noctilucent cloud observers — named NLC CAN-AM — hopes to expand the network for 1989, particularly into eastern North America. Anyone interested in contributing observations of the clouds can obtain report forms from Mark Zalcik at NLC CAN-AM, #2 14225 82 Street, Edmonton, Alberta, Canada T5E 2V7. □

The wonders and treasures of the universe – share them with your child!

Receive a FREE issue of ODYSSEY and a FREE moon booklet – "Let's Explore the Moon"

YOUR FREE MOON BOOKLET

"Let's Explore the Moon" is a colorful new booklet that teaches kids all about the exploration of the Moon – from the first historic footsteps to future Moon Bases. This easy-to-read booklet explains the changing phases of the Moon, and offers fun Moon projects!

Give your child the wonders and treasures of the universe. Challenge a young mind with the mysteries of space. Share the enjoyment you get from astronomy with your child. With ODYSSEY magazine! ODYSSEY, from the people who bring you ASTRONOMY, is the magazine of astronomy and outer space for young people (ages 8-14). ODYSSEY offers your child facts, not fiction, about outer space. ODYSSEY teaches the basics of astronomy and explores the new frontiers of outer space. ODYSSEY challenges youngsters to exchange ideas. ODYSSEY helps young people explore the night sky with articles and star charts. And ODYSSEY means fun, too, offering science related puzzles, games, and projects!

Now take advantage of a very special offer: Accept a FREE issue of ODYSSEY. If you like it, give your child the enjoyment of 12 issues – at a special introductory price! And, take advantage of this FREE issue offer and you'll also receive a FREE copy of the full-color booklet, "Let's Explore the Moon." Share the wonders of the universe – give your child ODYSSEY!

"ODYSSEY satisfies the intense interest many youngsters have in space and space exploration, laser technology, and new developments in astronomy. This clearly written magazine is handsomely designed and illustrated with many detailed photographs, drawings, charts, and maps. If you have a budding physicist or astronomer on your hands, ODYSSEY may be just what is needed to make his or her interest blossom."

Reprinted by special permission of Gifted Children Newsletter.

YES! Please send my child an issue of ODYSSEY – and the full-color "Let's Explore the Moon" booklet – FREE! We'll look over ODYSSEY and if we like it, I'll return payment of $19.95 when you bill me and we'll receive 11 additional issues. If not, I'll write "cancel" on the invoice and return it. Either way, the first issue – and the moon booklet – are ours to keep, at no obligation!

Send a copy of ODYSSEY and "Let's Explore the Moon" booklet to:

Child's name _____

Street _____

City, State, Zip _____

Send bill to:

My Name _____

Street _____

City, State, Zip _____

☐ **BILL ME LATER**

☐ **Payment enclosed**

Subscriptions to other countries: Remit $23.95 in U. S. currency. Allow 4-6 weeks for delivery.

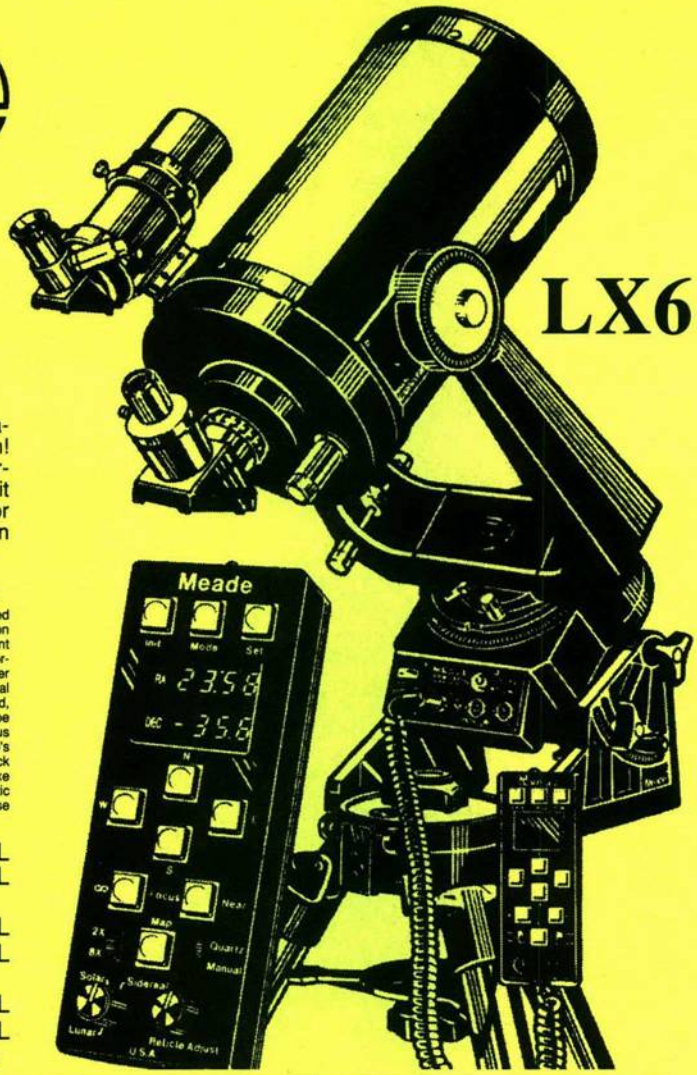
ODYSSEY,
1027 N. SEVENTH ST.
MILWAUKEE, WI 53233

O0077A

Authorized Meade Dealer

Meade

The *newest!*
The *fastest (f/6.3)!*
The *best-equipped!*
The *most fully-integrated!*
Meade's *top-of-the-line LX6's!*



Meade's new LX6's boast an *f*/6.3 optical system which permits astrographic exposures in only four-tenths of the time required by an *f*/10 system! In addition, they come complete with quartz-locked, micro-computer-controlled, electronic pulse-motor drive, sophisticated hand control unit with astrographic drive correction functions built-in, 2.00" star diagonal for advanced, premium-grade eyepieces, giant 9x60mm finderscope, built-in provision for optional digital readouts or CAT system, and much more!

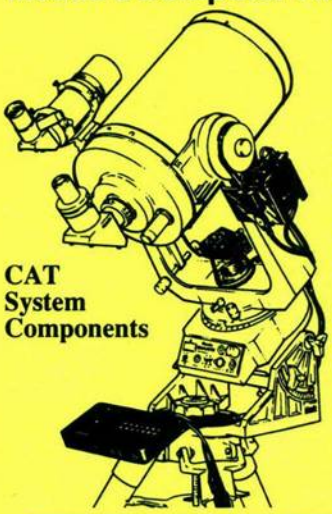
STANDARD FEATURES & FACTORY-SPECIFIED EQUIP:

Complete *f*/6.3 telescope tube assembly (8" or 10" aperture, 1,280mm or 1,600mm focal length), with certified diffraction-limited optical system; MCOG ("Multi-Coated Optics Group"), consisting of multi-layer anti-reflection coatings on corrector plate and enhanced reflectivity mirrors; ultra-smooth anti-backlash focus mechanism; giant 9x60mm illuminated-reticle polar-alignment viewfinder with quick-disconnect mounting bracket; 2.00" mirror-type star diagonal, with 1/10 wave multi-coated mirror and adapter for 1.25" eyepieces; Series 4000 26mm Super Plossl eyepiece, 1.25" (49x or 62x); rugged dual-fork astronomical mount with graduated setting circles, manual positioning controls and clutches on both axes of motion; digital quartz-locked, micro-computer-controlled, electronic sidereal-rate pulse-motor drive system and ultra-precision "LX" worm-drive gearing built into telescope drive base; Power Control Panel (also built into drive base) with controls, indicators and connectors for various accessory and auxiliary electronic equipment; Electronic Command Center hand-control unit (note: Meade's Digital Readout System is an ***optional*** accessory); 115Vac/60Hz power adapter with 25 ft. cord; DC battery-pack *(batteries not included)* with 4 ft. cord; 25 ft. DC power cord with automobile cigarette-lighter plug; Deluxe Equatorial Wedge with micrometric adjusters for latitude and azimuth, latitude scale, bubble level and magnetic compass; ultra-rigid adjustable-height Field Tripod; dust covers for optical apertures; foam-lined carrying case for scope-tube/fork-mount/drive-base assembly; instruction manual; limited lifetime warranty.

2080 LX6	(List: $ 4,400)	CALL
2120 LX6	(List: $ 6,400)	CALL
Optional Digital Readout System:		
Mod. 9068, *for* 2080 LX6	(List: $ 590)	CALL
Mod. 9070, *for* 2120 LX6	(List: $ 590)	CALL
Package: Telescope *and* Optional Digital Readout System, together:		
2080 LX6 *with* Mod. 9068	(List: $4,990)	CALL
2120 LX6 *with* Mod. 9070	(List: $6,990)	CALL

FREE FREIGHT! (UPS Ground) for the LX6's shown above

Meade's Computer-Aided Telescope System

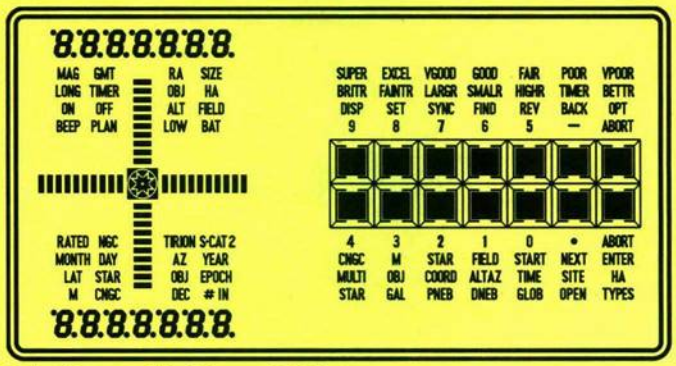


CAT System Components

Meade's Computer-Aided Telescope (the "CAT") system has most of the advantages of a computer-controlled telescope at only a fraction of the cost. Consisting of a specially-designed, high-speed, extremely powerful computer, along with a pair of high-resolution incremental shaft encoders and their associated mounting hardware, drive components and cabling (*see general arrangement drawing at left, and panel layout drawing at right*), the CAT can readily and quickly direct you to any of the thousands of celestial objects whose coordinates and other descriptive information are permanently stored in its 1Mb plug-in EPROM database, ***including all of the planets***, as well as to any other celestial object of known coordinates (comets, asteroids, quasars, super-novae, etc.). The computer is loaded with extra features and functionality as the panel legends, at right, indicate.

For the computer-literate, there is also a version of the CAT available with an RS-232C port (the "CAT-COM") for connection to a "PC" compatible personal computer. CAT-COM includes four "demonstration" software subroutines, written in BASIC, to show you how to address and control the CAT from your own computer, as well as the necessary RS-232C interconnect cable. The software is supplied on a 5.25" 360Kby diskette, with backup source-code listings in the instruction manual.

The CAT is available for most fork-mounted Schmidt-Cassegrain telescopes, but has been ***electronically integrated*** with the new LX6 series, so that the encoders and the CAT computer plug directly into the drive-base. Consequently, during our introduction of the LX6 series telescopes, we are offering extra savings on packages consisting of an LX6 telescope and one or the other of the CAT systems.



Optional Computer-Aided Telescope (CAT) System:		
CAT *for* 2080 *or* 2120 LX6	(List: $1,990)	CALL
CAT-COM *for* 2080 *or* 2120 LX6	(List: $2,290)	CALL
Package: Telescope *and* Optional CAT System, together:		
2080 LX6 *with* CAT	(List: $6,390)	CALL
2080 LX6 *with* CAT-COM	(List: $6,690)	CALL
2120 LX6 *with* CAT	(List: $8,390)	CALL
2120 LX6 *with* CAT-COM	(List: $8,690)	CALL
Hardcopy Listing of CAT Database	(List: $ 60)	CALL

OUR GUARANTEE: We are solely, exclusively, professionally, a first-line, quality telescope dealership. We guarantee, unconditionally, that when you purchase a telescope or other equipment from us, you will receive all of the equipment and accessories that its manufacturer specifies for it. ***We do not*** "strip" scope kits, ***nor do we*** charge extra for the equipment, accessories or warranties intended by the manufacturers to be included with their equipment. When you buy from us, you will receive everything you pay for - you can dount on it. We further guarantee, unconditionally, that all equipment sold by us is brand-new and factory-fresh. ***We do not*** take unscrupulous advantage of distant and helpless mailorder buyers; ***we do not*** buy and ***we do not*** sell ***RETURNED***, reconditioned, rebuilt, demonstrator, floor-sample, shopworn, used, loaner, rental, prototype, cosmetic defect, factory-second or otherwise imperfect goods. NO OTHER MAIL-ORDER DEALER, TO OUR KNOWLEDGE, MAKES AND PUBLISHES SUCH A GUARANTEE! DON'T BE FOOLED; BUY ONLY FROM A REPUTABLE DEALER.

california telescope company

CA & AK, OR FOR INFORMATION, CALL (818) 505-8424. Interbank wire transfers, DiscoverCard, MasterCard & Visa accepted - no surcharge. Most items free UPS Ground shipping in the contiguous 48 states. California shipping addresses add sales tax. Send business-size SASE for ***Free Discount Price List***; $5 ($8 foreign) check or MO for Catalog Package. RFQ's welcome. Prices and specifications are subject to change without notice or obligation. All sales are final.

P.O. Box 1338, Burbank, California 91507
TOLL-FREE, ORDERS ONLY, 10-4 Pacific Time, Mon-Fri:
(800) 843-4780

Astronomy AS8902MA.PM3

Authorized Meade Dealer

Meade

MEADE has a TELESCOPE for every PURPOSE and BUDGET!

Meade's Schmidt-Newtonians
Rich, Fast and Photographic!

Shown: MTS-SN6 with optional and accessory equip.

FREE FREIGHT!

These scopes' wide, bright, highly corrected fields of view ("rich"-fields) and "fast" focal ratios make them ideal for both deep space visual observing and prime focus astrophotography. Easy and convenient to transport and use because of their "fork" -type equatorial mounts, they are excellent all-around scopes for those just starting in astronomy, as well as for experienced astrophotographers. Their 1.25"/2.00" focusers not only permit the use of the greatest variety of eyepieces, but also allow the fullest illumination of the film-plane during photography. 6" scope available with or without Mod. 788 motor drive. 8" scope available with Mod. 788 motor drive, or "LX3" quartz-synchronized microelectronic drive system for maximum accuracy and precision. All are available with or without "MCOG" (multi-coated optics group) optical coatings, which enhance brightness and contrast of visual and photographic images.

Specs: Basic MTS-SN6: Complete 6"A, f/5 Schmidt-Newtonian telescope tube assembly (152.4mm aperture, 762mm focal length); 2" helicoid focuser, with 1.25" adapter; 25mm (30x) MA eyepiece, 1.25" barrel; rugged dual-fork equatorial astronomical mount with graduated setting circles, latitude adjustment, and latitude scale; pipe-pier stand with quick-mount tri-legs; dust cover; instruction manual; limited lifetime warranty.

Ask about our special finderscope & barlow Accessory Packages for these MTS Schmidt-Newtonians

Specs: Basic MTS-SN8: Complete 8"A, f/4 Schmidt-Newtonian telescope tube assembly (203.2mm aperture, 812.8mm focal length); 2" helicoid focuser, with 1.25" adapter; 25mm (32.5x) MA eyepiece, 1.25" barrel; rugged dual-fork equatorial astronomical mount with graduated setting circles, latitude adjustment, and latitude scale; Mod. 788 ***worm-gear drive***, 115Vac 60Hz; pipe-pier stand with quick-mount tri-legs; dust cover; instruction manual; limited lifetime warranty.

MTS-SN6	(List: $ 1,050)	CALL
MTS-SN6, MCOG	(List: $ 1,130)	CALL
MTS-SN6, 788 MtrDrv	(List: $ 1,200)	CALL
MTS-SN6, 788 MtrDrv, MCOG	(List: $ 1,280)	CALL
MTS-SN8, 788 MtrDrv	(List: $ 1,500)	CALL
MTS-SN8, 788 MtrDrv, MCOG	(List: $ 1,590)	CALL
MTS-SN8, LX3 MtrDrv	(List: $ 1,800)	CALL
MTS-SN8, LX3 MtrDrv, MCOG	(List: $ 1,890)	CALL

Meade's MTS Schmidt-Cassegrains
Best-Value All-Around Performers!

Shown: MTS-SC10 with optional and accessory equip.

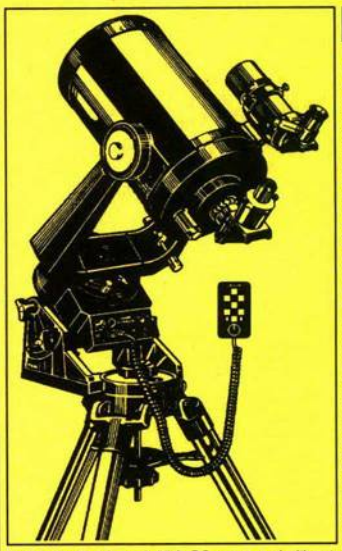
FREE FREIGHT!

These scopes' "general-purpose" f/10 focal ratios and modest prices make them the best-value "all-purpose", "do-everything" scopes available. Optically capable of delivering exquisite views and photographs of almost all types of astronomical objects "as-is", they may nevertheless be extended to extremely "fast" effective focal ratios and correspondingly wide fields of view by means of telecompressor accessories, or to extremely high power, narrow-field lunar, planetary and multiple-star work by means of Barlow lens accessories. Each scope is available with or without "MCOG" (multi-coated optics group) optical coatings, which enhance brightness and contrast of visual and photographic images, and with either the Mod. 788 motor drive, or the "LX3" quartz-synchronized micro-electronic drive system for maximum accuracy and precision. Compact, portable, easy to use visually and photographically, and with Meade's high-quality optics, the MTS Schmidt-Cassegrains are an extraordinary value in astronomical telescopes.

Specs: Basic MTS-SC8 and MTS-SC10: Complete 8"A (SC8) or 10"A (SC10) f/10 Schmidt-Cassegrain telescope tube assembly (203.2mm [SC8] or 254mm [SC10] aperture, 2,000mm [SC8] or 2,500mm [SC10] focal length), with certified diffraction-limited optical system; ultra-smooth anti-backlash focus mechanism; 6x30mm (SC8) or 8x50mm (SC10) viewfinder; 1.25" visual accessory holder; 1.25" anti-reflection coated prism-type star diagonal; 25mm (80x [SC8] or 100x [SC10]) MA eyepiece, 1.25" barrel; rugged dual-fork equatorial astronomical mount with graduated setting circles, latitude adjustment; and latitude scale; Mod. 788 **worm-gear drive**, 115Vac 60Hz; pipe-pier stand with quick-mount tri-legs; dust covers for optical apertures; instruction manual; limited lifetime warranty.

MTS-SC8, 788 MtrDrv	(List: $ 1,800)	CALL
MTS-SC8, 788 MtrDrv, MCOG	(List: $ 1,890)	CALL
MTS-SC8, LX3 MtrDrv	(List: $ 2,150)	CALL
MTS-SC8, LX3 MtrDrv, MCOG	(List: $ 2,240)	CALL
MTS-SC10, 788 MtrDrv	(List: $ 2,780)	CALL
MTS-SC10, 788 MtrDrv, MCOG	(List: $ 2,950)	CALL
MTS-SC10, LX3 MtrDrv	(List: $ 3,180)	CALL
MTS-SC10, LX3 MtrDrv, MCOG	(List: $ 3,350)	CALL

Meade's LX5's



Fully equal to LX6's in terms of their standard equipment, they come complete with quartz-lock microelectronic pulse motor drive, sophisticated hand control unit with photographic drive correction functions built-in, 2.00" star diagonal for advanced, premium-grade eyepieces, & giant 9x60mm finder-scope!

Specs: 2080/LX5 and 2120/LX5: Complete 8"A (2080/LX5) or 10"A (2120/LX5) f/10 Schmidt-Cassegrain telescope tube assembly (203.2mm or 254mm aperture, 2,000mm or 2,500mm focal length), with certified diffraction-limited optical system; MCOG ("Multi-Coated Optics Group"), consisting of multi-layer anti-reflection coatings on corrector plate and enhanced reflectivity mirrors; ultra-smooth anti-backlash focus mechanism; giant 9x60mm illuminated-reticle polar-alignment viewfinder with quick-disconnect mounting bracket; 2.00" mirror-type star diagonal, with 1/10 wave multi-coated mirror and adapter for 1.25" eyepieces; Series 4000 26mm Super Plossl eyepiece, 1.25" (77x or 96x); rugged dual-fork astronomical mount with graduated setting circles, manual positioning controls and clutches on both axes of motion; digital quartz micro-electronic sidereal-rate pulse-motor drive system and ultra-precision "LX" worm-drive gearing built into telescope drive base; Power Control Panel (also built into drive base) with controls, indicators and connectors for various accessory and auxiliary electronic equipment; Electronic Command Center hand-control unit; 115Vac 60Hz AC power adapter with 25 ft. cord; DC battery-pack *(batteries not included)* with 4 ft. cord; 25 ft. DC power cord with automobile cigarette-lighter plug; Deluxe Equatorial Wedge with micrometric adjusters for latitude and azimuth (polar-alignment adjustments), latitude scale, bubble level, magnetic compass (and no-tool knob set on 8" scope only); ultra-rigid adjustable-height Field Tripod; dust covers for optical apertures; foam-lined carrying case for scope-tube/fork-mount/drive-base assembly; audio cassette instructions; instruction manual; limited lifetime warranty.

2080/LX5, MCOG, Wedge, Tripod (as above)	(List: $ 3,800)	CALL
2120/LX5, MCOG, Wedge, Tripod (as above)	(List: $ 5,400)	CALL

FREE FREIGHT! (UPS Ground) for the LX5's above

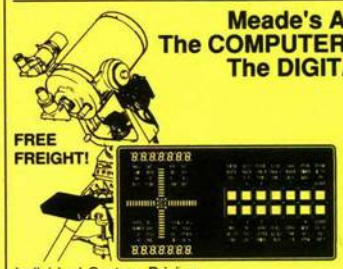
Meade's LX3's - Still Going STRONG!

Specs: 2080/LX3 and 2120/LX3: Complete 8"A (2080/LX3) or 10"A (2120/LX3) f/10 Schmidt-Cassegrain telescope tube assembly (203.2mm or 254mm aperture, 2,000mm or 2,500mm focal length), with certified diffraction-limited optical system; MCOG ("Multi-Coated Optics Group"), consisting of multi-layer anti-reflection coatings on corrector plate and enhanced reflectivity (multi-layer over-coated) mirrors; ultra-smooth anti-backlash focus mechanism; large 8x50mm viewfinder; 1.25" visual back (eyepiece holder); 1.25" prism-type star diagonal, anti-reflection coated; 25mm (80x or 100x) MA eyepiece, 1.25" barrel; rugged dual-fork astronomical mount with graduated setting circles, manual positioning controls and clutches on both axes of motion; quartz micro-electronic sidereal-rate drive system and ultra-precision "LX" worm-drive gearing built into telescope drive base; Power Control Panel (also built into drive base) with controls, indicators and connectors for various accessory and auxiliary electronic equipment; Electronic Command Center hand-control unit **(10" 2120/LX3 only)**; 115Vac 60Hz AC power adapter with 25 ft. cord; 25 ft. DC power cord w/cigarette-lighter plug; Deluxe Equatorial Wedge with micrometric adjusters for latitude and azimuth (polar-alignment adjustments), latitude scale, bubble level and magnetic compass (and no-tool knob set on 8" scope only); ultra-rigid adjustable-height Field Tripod; dust covers for optical apertures; foam-lined carrying case for scope-tube/fork-mount/drive-base assembly; instruction manual; limited lifetime warranty.

2080/LX3, MCOG, Wedge, Tripod (as above)	(List: $ 3,520)	CALL
2120/LX3, MCOG, Wedge, Tripod (as above)	(List: $ 5,200)	CALL

FREE FREIGHT! (UPS Ground) for the LX3's above

Meade's Advanced Electronic Systems
The COMPUTER-AIDED TELESCOPE System
The DIGITAL SETTING CIRCLE System



FREE FREIGHT!

Meade's "CAT" and "DSC" Systems enhance your ***observing*** pleasure by virtually eliminating the difficulties of "finding". Sophisticated micro-computer technology and software make it possible! The CAT System (at left), contains an internal catalog of over 7,500 astronomical objects. The DSC System provides precise, digital coordinate readout too, but without the internal catalog. Both systems are easy, bolt-on retrofits - no drilling or tapping required. A variant of the CAT ("CAT-COM") can communicate with a PC-type computer (see opposite page for details). Package pricing is available when either System is purchased at the same time as its telescope (not for MTS).

Individual System Pricing:

DSC Sys., for 2080, 2120, C8 or C11	(List: $ 700)	CALL
CAT Sys., for 2080, 2120, C8 or C11	(List: $ 1,990)	CALL
CAT-COM, for 2080, 2120, C8 or C11	(List: $ 2,290)	CALL

Package Pricing (Electronics System purchased at same time as its telescope):

DSC Sys., for 2080, 2120, C8 or C11	(List: $ 700)	CALL
CAT Sys., for 2080, 2120, C8 or C11	(List: $ 1,990)	CALL
CAT-COM, for 2080, 2120, C8 or C11	(List: $ 2,290)	CALL

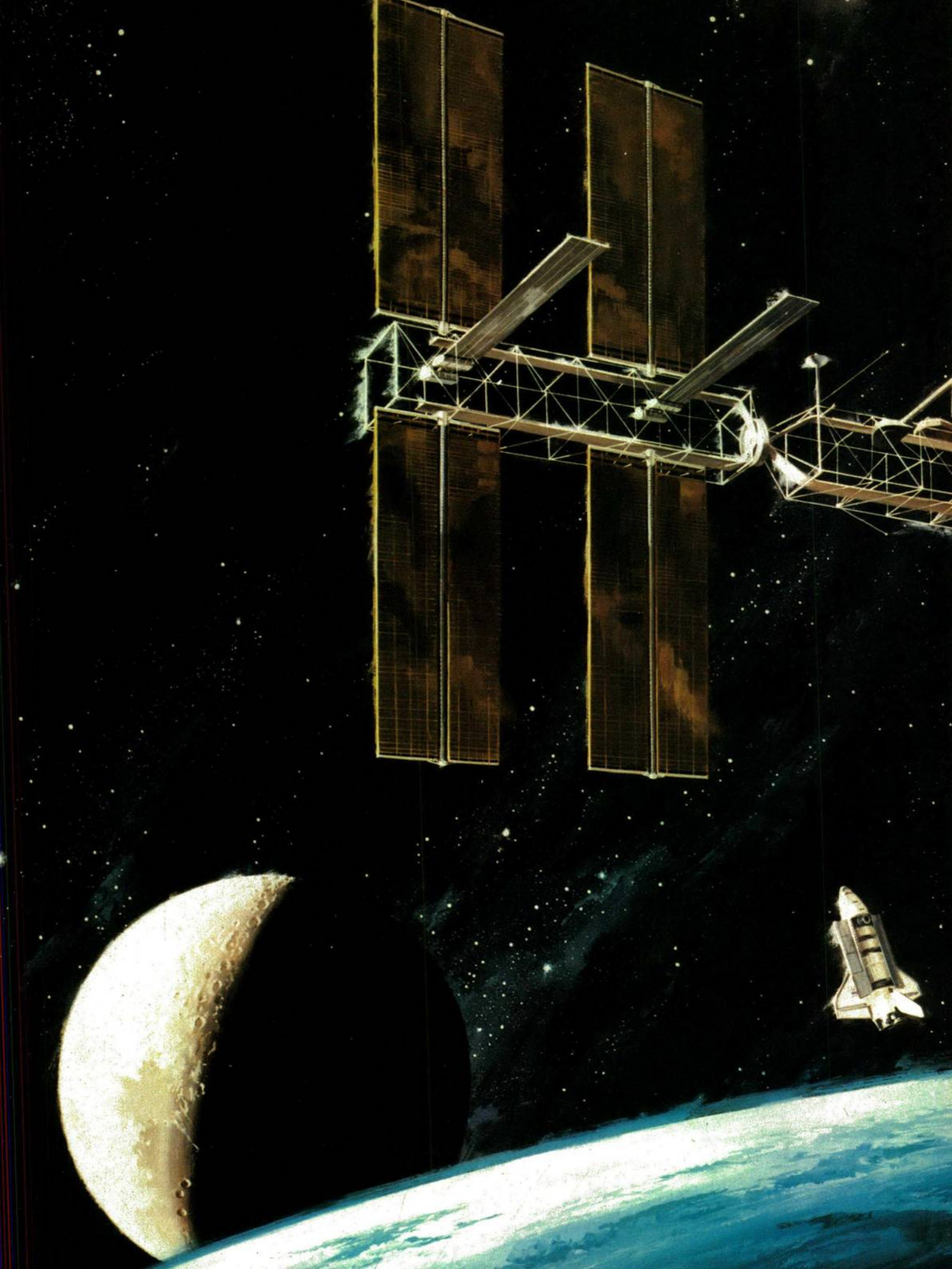
OUR GUARANTEE: We are solely, exclusively, professionally, a first-line, quality telescope dealership. We guarantee, unconditionally, that when you purchase a telescope or other equipment from us, you will receive all of the equipment and accessories that its manufacturer specifies for it. ***We do not*** "strip" scope kits, ***nor do we*** charge extra for the equipment, accessories or warranties intended by the manufacturers to be included with their equipment. When you buy from us, you will receive everything you pay for - you can count on it. We further guarantee, unconditionally, that all equipment sold by us is brand-new and factory-fresh. ***We do not*** take unscrupulous advantage of distant and helpless mailorder buyers; ***we do not*** buy and ***we do not*** sell ***RETURNED***, reconditioned, rebuilt, demonstrator, floor-sample, shopworn, used, loaner, rental, prototype, cosmetic defect, factory-second or otherwise imperfect goods. NO OTHER MAIL-ORDER DEALER, TO OUR KNOWLEDGE, MAKES AND PUBLISHES SUCH A GUARANTEE! DON'T BE FOOLED; BUY ONLY FROM A REPUTABLE DEALER.

california telescope company

CA & AK, OR FOR INFORMATION, CALL (818) 505-8424. Interbank wire transfers, DiscoverCard, MasterCard & Visa accepted - no surcharge. Most items free UPS Ground shipping in the contiguous 48 states. California shipping addresses add sales tax. Send business-size SASE for ***Free Discount Price List***; $5 ($8 foreign) check or MO for Catalog Package. RFQ's welcome. Prices and specifications are subject to change without notice or obligation. All sales are final.

P.O. Box 1338, Burbank, California 91507
TOLL-FREE, ORDERS ONLY, 10-4 Pacific Time, Mon-Fri:
(800) 843-4780

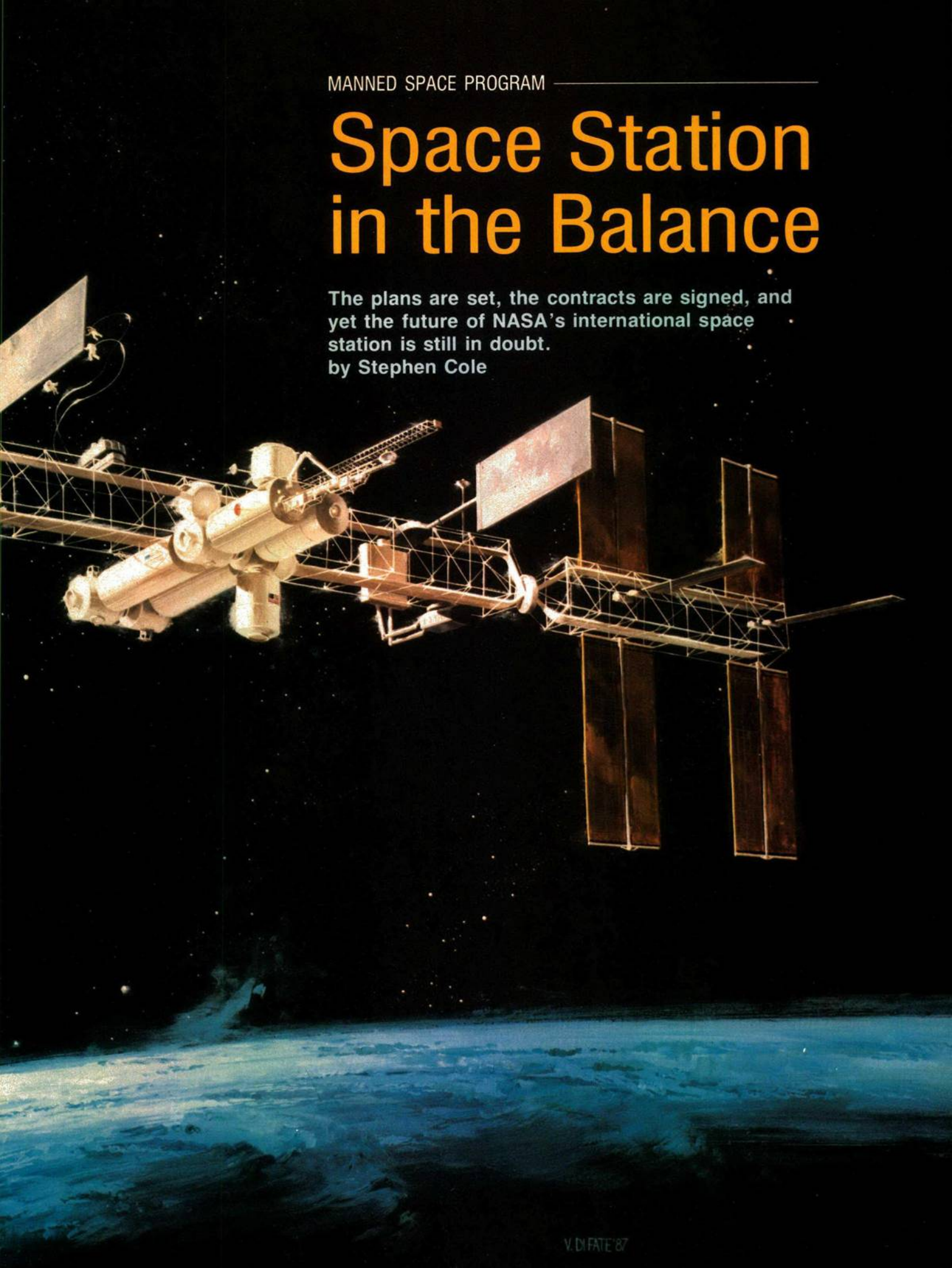
Astronomy AS8902MB.PM3



MANNED SPACE PROGRAM

Space Station in the Balance

The plans are set, the contracts are signed, and yet the future of NASA's international space station is still in doubt.
by Stephen Cole



Nineteen eighty-eight was a pivotal year for the U.S. Space Station program. The five-year-old project overcame ardent opposition in its annual budget encounter with Congress and won twice the money it had received in 1987. The Station played a key role in President Reagan's national space policy directive, which set the future direction for the U.S. space program. Japan, Canada, and Europe formally joined the project after three years of negotiation. And the Station finally got a name — *Freedom*.

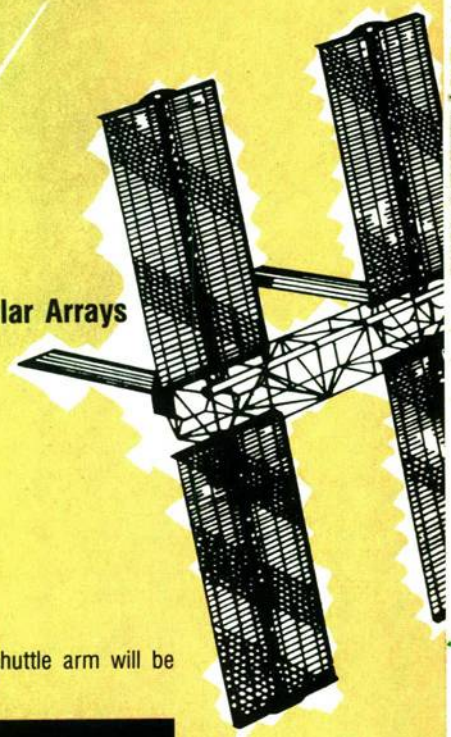
If this momentum continues, the United States and its allies will have a permanently staffed orbiting laboratory completed in nine years.

But despite the progress made last year, the Space Station entered 1989 in a precarious position. The project's chief advocate, Ronald Reagan, has left office. A deficit-conscious Congress has been asked to again double the Station's budget, this time to $2 billion.

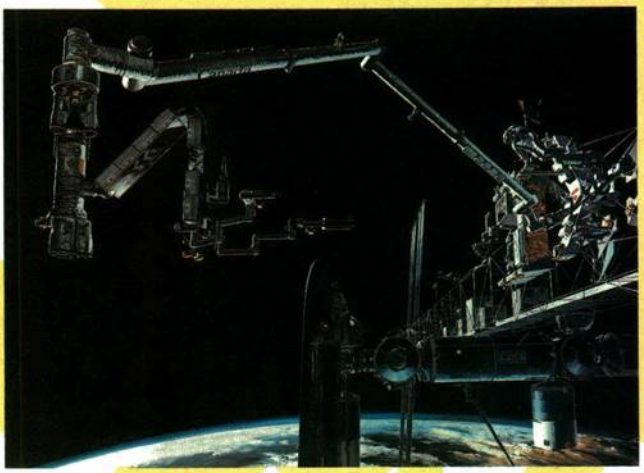
What's at stake is more than the fate of just another NASA program. To its advocates, the Space Station *is* the NASA program of the next century. "The Space Station is really the key to the future of the United States space program," NASA administrator James Fletcher stressed to Congress last year, "both for the full exploitation of space and Earth orbit, and for human exploration beyond Earth orbit."

To its critics, the Station is an unwieldy juggernaut that lacks a clear, significant purpose and is so expensive it may ultimately devastate NASA's other programs. Before the project is completed, the United States will have to spend $25 billion and commit billions more to keep the Station in orbit and staffed over its projected thirty-year lifetime.

Space Station construction and maintenance will get a helping hand from the U.S.-developed Telerobotic Servicer.



A stronger version of the Canadian-developed shuttle arm will be mounted on the Station for heavy lifting chores.



A Mature Design

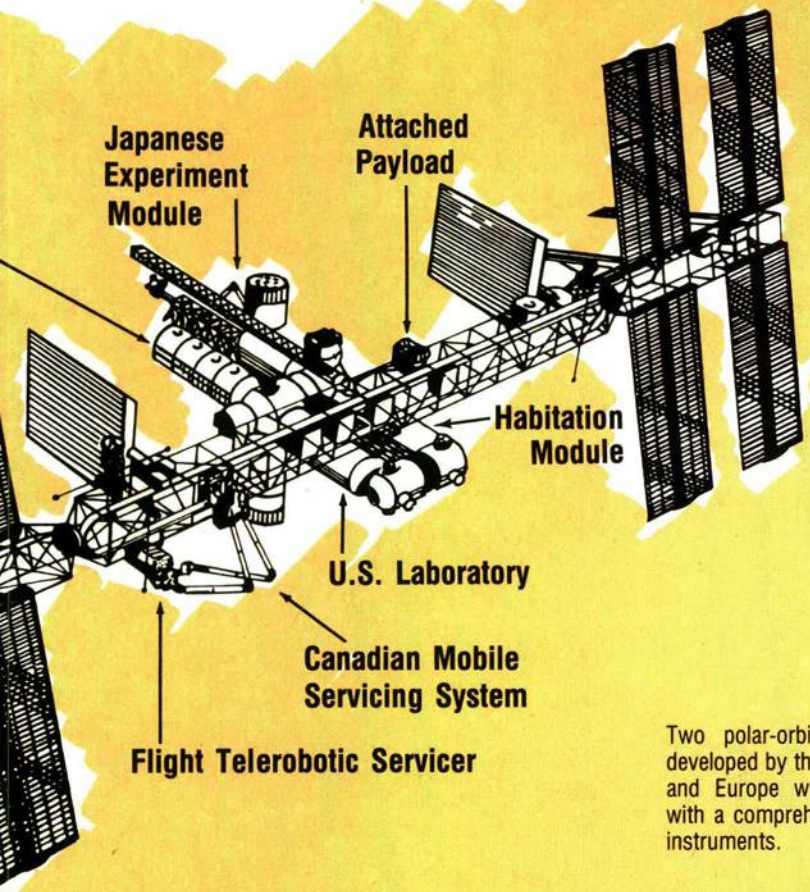
The future of Space Station *Freedom* is now up to Congress and the president. For its part, NASA has brought the project to the point where detailed designs are in hand and construction is nearly ready to begin. Since President Reagan initiated the Station in his 1984 State of the Union address, the project has steadily progressed through a number of reviews and revisions. The original design was scaled down to the current design with all Station components attached to a single beam structure. This "Phase I" design could later grow into a larger Station.

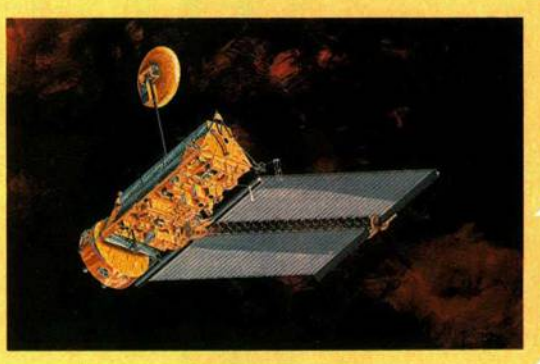
In a major review of the project requested by Reagan in 1987, the National Research Council declared the Phase I design the best one available. In December 1987 NASA hired four teams of contractors to develop advanced designs of the various Station components. These teams, headed by Boeing Aerospace, McDonnell Douglas Astronautics, General Electric's Astro-Space Division, and the Rocketdyne division of Rockwell International, will also build the Station. A comprehensive review of their progress is scheduled for later this year.

Surprisingly, for a project as far along in its development and as big and controversial as the Space Station is, it has so far made a very small impression on the national consciousness. A recent survey found that only one in three Americans are aware of the Space Station. This may be due in part to the project's inherent lack of glamour. The Station will not travel to another planet, nor will it yield startling new views of the universe. The Space Station is a laboratory: a versatile, zero-gravity laboratory staffed around the clock but, essentially, just a laboratory.

What makes the Space Station unique is the type of research that will be conducted there and the engineering advances that its creation will produce. Microgravity research in both the materials and life sciences — the type of experiments that have been

A Multifaceted Laboratory in Space





Two polar-orbiting platforms developed by the United States and Europe will study Earth with a comprehensive suite of instruments.

Experiments in materials and life sciences will be conducted in the Station's three laboratory modules.

Twenty space shuttle flights will carry Station hardware and crew into their 200-mile-high orbit.

performed on the space shuttle — will now become a year-round activity. An advanced, global study of Earth will also be conducted as part of the Station program. The Station crew itself will be part of research into the effects of extended stays in space on humans.

The new technologies used in building the Station — constructing large structures in space, closed life-support systems, advanced robotics — will be essential to future manned missions beyond Earth orbit. A recent report by NASA's Office of Exploration, which is developing plans for such missions, stated: "As a base to gain long-duration operations experience, to conduct life sciences research, and to function as a testbed to demonstrate technology, Space Station *Freedom*'s contributions to human exploration of the solar system will be monumental."

As currently designed, the Space Station will be a 500-foot-long beam with the manned base of four interconnected cylindrical modules at the center of the beam and solar power arrays at both ends. Three of the 14-foot-wide, 44-foot-long modules are laboratories, one each from Japan, the European Space Agency, and the United States; the fourth module is the U.S.-built living quarters for the

Building toward 1998

With the U.S. laboratory in place, the Station becomes operational; crews reside in the shuttle

Habitation module arrives

1995 Launches per year

1996

U.S. polar platform launched

Station is permanently occupied by crew members

eight-person crew.

The Station will have 32,000 cubic feet of pressurized space, compared to the Soviet Union's *Mir* space station, launched in 1986, which currently has a volume of 6,200 cubic feet and is scheduled to grow to 15,000 cubic feet by the mid-1990s. The modules are pressurized and provide a "shirt-sleeve" environment for performing experiments. The Japanese module has the added capability of performing experiments outside the module. A 25-foot-long exposed pallet is attached to the module and a robotic arm transfers experiments to and from the pallet through an air lock.

The agreement signed last September by all the Space Station's international partners allocates use of the three laboratories based on the contribution of each country to the overall program. For supplying the lion's share of the total cost, the United States receives the use of its lab module and almost half of the other two labs. Japan and Europe own half the space on their labs; Canada receives 3 percent of each lab.

The Station is powered by four arrays of photovoltaic cells that, if laid side by side, would cover half an American football field. The electrical output of these cells is 75,000 watts, of which 45,000 are available to power the various scientific instruments. (*Mir*'s power output is expected to be 16,000 watts in the 1990s.) The solar array portions of the Station's beam pivot so the arrays constantly face the Sun.

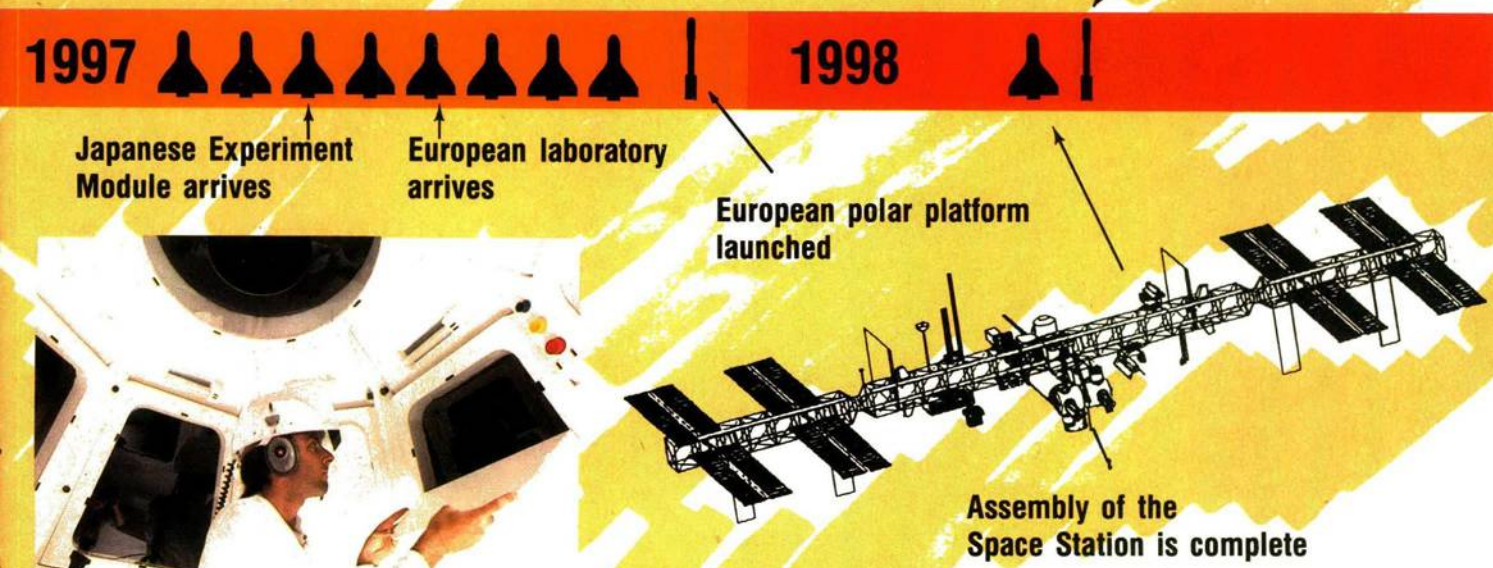
Planned to Grow

The basic Phase I Station is designed to be expandable. Additional beam structures can be added to the central beam. More pressurized modules can be connected to the current four. The Station will be able to grow into a larger research lab or a construction facility for building interplanetary spacecraft at some later time.

Not all the research facilities of the current Space Station program are located on the Station proper. The European Man-Tended Free Flyer module, identical in size to the laboratory modules on the Station yet orbiting independently, will carry microgravity experiments. This unmanned lab will be serviced periodically at the Station and by the European space plane, *Hermes*, which is currently in development.

Two other research facilities, the European and U.S. polar platform satellites, will have no physical contact with the Station or any other Station component. The platforms will circle Earth over the poles while the Station's orbit is inclined 28.5° to the equator. Most of the program's Earth-observation instruments will be carried on these platforms.

The Space Station and its flock of associated spacecraft will go into



operation in stages over the three-and-a-half years required for construction. Twenty space shuttle flights are planned to assemble the Station; the polar platforms and the European free flyer will be launched by rocket. The number of shuttle flights could be reduced to fourteen if NASA replaces the shuttle's current solid rocket booster with a new solid rocket motor currently under study. The new booster would increase the shuttle's payload capacity by 12,000 pounds.

First Launch: 1995

The first element of the Station is scheduled for launch into its 200-mile-high orbit in early 1995. Three shuttle launches later, with half of the central beam, one solar array, and the U.S. lab module in place, the Station begins to produce science on a limited basis. Experiments are conducted by astronauts living in the shuttle, which is docked to the Station.

The construction of the Station will rely on two automated systems being developed by the United States and Canada. The Mobile Servicing Center is a robotic system descended from the Canadian remote manipulator "arm" used in the shuttle cargo bay. The automated arm, which is three times stronger than the shuttle's, rides along rails mounted to the central beam, picking Station elements out of the shuttle's bay and carrying them to the assembly area.

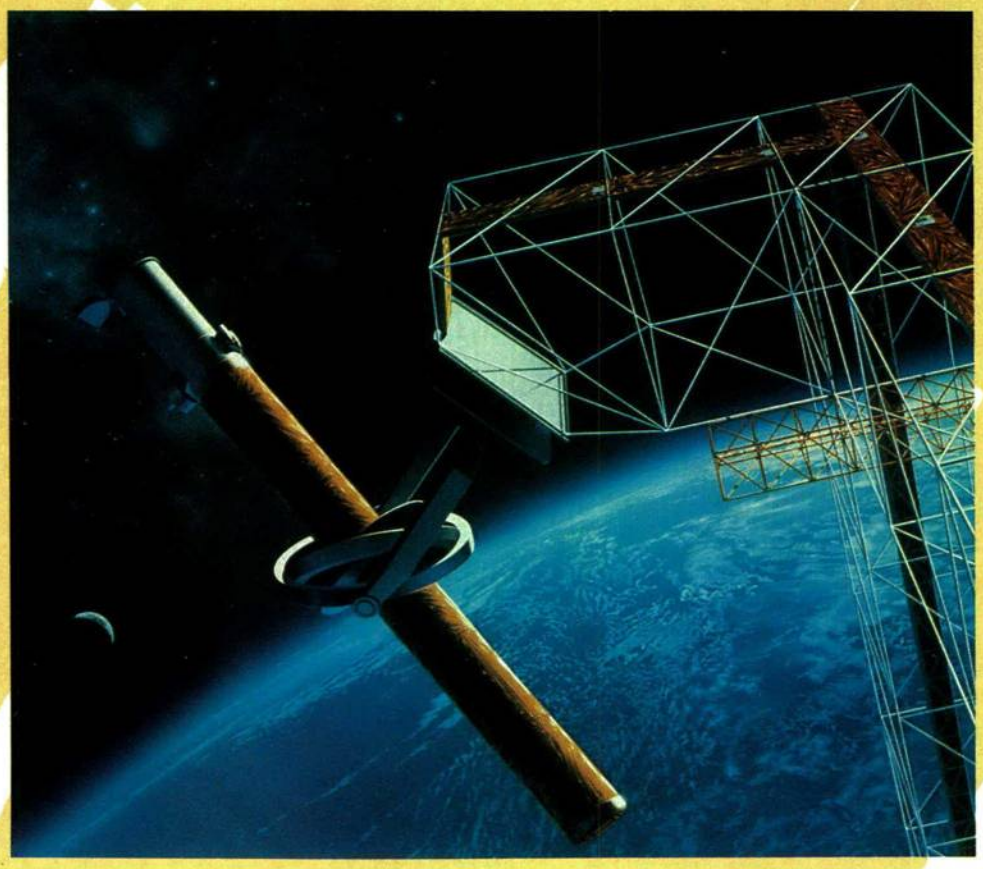
For smaller-scale tasks, like assembling the beam and installing fixtures on it, the United States is developing the Flight Telerobotics System. This multiarmed robot will be operated by astronauts using programmed command sequences as well as direct manual control to reduce the amount of time required by humans for construction activities outside the Station. After construction is completed, both robotic systems will be used for Station maintenance.

Soon after the arrival of the U.S. habitation module in late 1996, the Station reaches the permanently manned stage. The central beam is complete and solar arrays have been attached to each end.

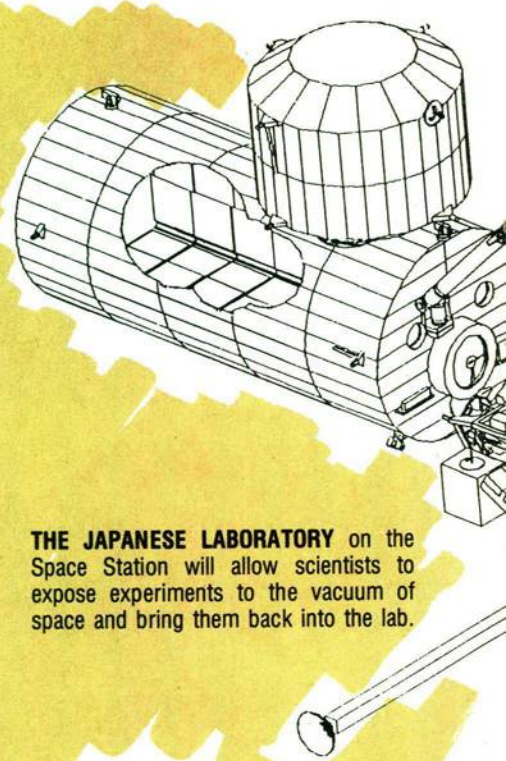
At this point the Station receives its "lifeboats." Two vehicles capable of carrying six astronauts apiece will be moored at the Station in case of an emergency. NASA has not yet selected the design for these vehicles, but alternatives include an *Apollo*-like capsule and a small space plane capable of a runway landing.

The European and Japanese lab modules arrive in 1997 and the Station is complete by early 1998. Up to eight shuttle flights a year will be needed to ferry crews and supplies to the Station. Resupplying the Station may eventually be done by unmanned boosters.

The primary scientific research conducted inside the Space Station laboratories will be in materials science and life sciences. Previous space-based research has shown the value of a microgravity environment for studying certain natural processes. Protein crystals grown in the absence of gravity, for example, are large and pure enough to reveal details of their molecular structure. This knowledge could allow these proteins to be synthesized on Earth. Similarly, microgravity experiments with metals and



SEARCHING FOR PLANETS around nearby stars is the objective of the proposed Astrometric Telescope Facility, which could be attached to an expanded Station.



THE JAPANESE LABORATORY on the Space Station will allow scientists to expose experiments to the vacuum of space and bring them back into the lab.

alloys can lead to the development of materials with new or improved properties.

In the life sciences, plants, animals, and microorganisms will be studied on the Space Station through several life cycles to assess the physiological effects of weightlessness. A life-support system that produces oxygen, water, and food from microorganisms and plants will also be developed.

The Station's microgravity research facilities, including a centrifuge to produce variable gravity and a furnace for materials processing, will evolve from equipment used on the space shuttle. A series of shuttle *Spacelab* flights are scheduled for the early 1990s to test the Station's instruments.

Another class of scientific disciplines — those that seek to understand space, not just use it as a working environment — will be conducted outside the Station labs. Experiments can be attached to four utility ports along the central beam for Earth observation and space science research. A variety of instruments, from a cosmic dust collector to automated telescopes, have been proposed for these "attached payload" positions.

"The Space Station will provide resources on orbit that were not previously available," said David C. Black, director of the Lunar and Planetary Institute in Houston and former chief scientist on the Space Station. "It will have frequent transportation already in place and a fair amount of real estate too. Although the advance of space science does not depend on the Space Station, if the nation is going to build it, for any number of reasons, the question is, can it be used for science? The answer is yes."

The ability to get experiments into orbit rapidly is an attribute of the attached payloads that Black feels will benefit space science research. Black chaired a NASA study group in 1987 that examined opportunities on the Station for this type of "quick is beautiful" experiment, which would allow more access to space for graduate student experiments and test flights for experimental hardware.

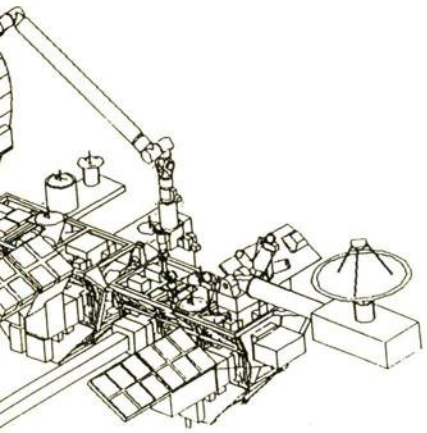
"Since you wouldn't have to design and build a spacecraft for each new mission anymore, science can now be the main concern," said Black. "Payloads could be developed and flown within a couple of years." Black hopes to see this type of research made an official part of the Station's ongoing science program.

The long lifetime of the Station — up to thirty years — is another attribute of the Station especially useful to astronomy. One of the payloads currently being considered by NASA is the "Space Station Remote Access Automatic Observatory" proposed by Bruce Rafert, director of the Florida Institute of Technology's Space Research Institute. Several small automated telescopes attached to the Station beam will make photometric observations of stars and asteroids with much higher precision than is possible from Earth. The scopes would be remotely controlled by investigators on Earth.

Planet Search Proposed

On the larger end of the research spectrum, Black is working on a proposal for the post-Phase I Space Station that will search for planets around nearby stars. The Astrometric Telescope Facility, a 1-meter telescope over 50 feet long attached to its own beam, would conduct a survey of one hundred stars. Over a twenty-year period the telescope would look for regular variations in the motions of stars caused by a massive planet orbiting the star. The survey would yield fundamental data on the existence of planetary systems around different types of stars.

According to Black, interest in the Space Station is high in the scientific community. "NASA may find more users in the end than it can handle." But not everyone is happy about the type of scientific research planned for the Space Station. The heavy emphasis on materials science, with the



anticipation of reaping commercial benefits from the development and manufacturing of new materials in orbit, has been criticized as a misguided — and illusory — purpose for a space station.

The commercial potential of the Space Station has been a dominant ingredient in Reagan's conception of the project since it began. "A space station will permit quantum leaps in our research in science, communications, and in metals and life-saving medicines which can be manufactured only in space," Reagan said in announcing the project in 1984.

Commercial involvement in the Station would also include investment in constructing Station hardware and services that private businesses would profit from indirectly through the development of new technologies or directly through fees charged to users, including NASA. In his 1988 National Space Policy declaration, Reagan directed NASA to "rely to the greatest extent feasible on private sector design, financing, construction, and operation of future Space Station requirements."

But a recent report by the National Academies of Science and Engineering strongly advises George Bush to abandon his predecessor's reliance on a commercial justification for the Space Station. "Emphasis on microgravity research as a major station justification has not provided a strong political or scientific foundation for the program," stated the report, titled "Toward a New Era in Space."

"The principal long-term reason for having a space station is to support eventual deep-space manned space flight," said H. Guyford Stever, former director of the National Science Foundation and chairman of the Academies' committee on space policy, which issued the report. "The committee believes that should be the priority aim."

"The most sustainable rationale for today's manned space program," the report added, "is related to the research and technology development activities that are necessary precursors to any decision to commit the United States to sending humans to Mars for initial exploration or back to the Moon for extended stays."

The report recommends that Bush establish manned exploration as the dominant purpose for the Space Station before committing to the current plan. "Early in his Administration, the President must decide how well the current plans for the Space Station fit his priorities for space and for the federal budget. We believe that a permanently manned space station is essential to establish the feasibility of human exploration. But its final configuration, pace of deployment, and funding level should not be established without prior decisions on American goals in space."

Rethinking the Station?

The report does not call for an immediate halt in the program or any drastic restructuring of the current plan. "Final decisions regarding the configuration of such a station should await the President's decisions regarding goals. . . . Although this kind of plan implies a reorientation in the primary rationale for the Space Station and a rethinking of plans for outfitting and utilizing it, it may not require major shifts in the current design." The report suggests devoting the U.S. laboratory module to life sciences research and moving materials science experiments to the other two labs.

President Bush has so far failed to heed the National Academies' advice. In February Bush made his first statement on the Space Station since taking office and pledged to continue the program but made no recommendations to shift it from commercialization to solar system exploration.

And so the Space Station enters a new round of budget negotiations with the tacit backing of a new president but without a revised sense of purpose. With the obstacles facing the project this year, it is uncertain whether that will be enough to keep it on course.

The president is requesting the biggest Space Station budget yet — $2 billion — and the largest one-year increase the program will ever have. In its first three years the Space Station received approximately what it had requested, but these budgets were all less than $500 million. When the request in 1987 jumped to $767 million, Congress cut it by nearly half.

That budget cut was a blow to the Station program and resulted in a major revamping of the construction timetable. "That cut was devastating to the Space Station," said NASA administrator Fletcher at Senate hearings last year. "I was close to recommending that we just terminate it, but we hung on."

The funding approved in 1988 — $900 million — was less than $100 million short of what NASA had requested. This was considered a victory for the Space Station, but it did not signal a fundamental change of heart on Capitol Hill. In its final report on NASA's budget the Senate Committee on Commerce, Science, and Transportation stated: "The Committee has been deeply concerned about the fate of the Space Station program. The lack of financial commitment to the program has already extended the proposed schedule and has dramatically increased the proposed costs. . . . The Committee feels strongly that the Space Station program is a national priority and should be a budget priority. Unfortunately, there does not yet appear to be a consensus in the Congress on that position."

The final wording of the NASA bill made it clear just how weak that support was. Although Congress did authorize $900 million for the Station, it also decided to freeze $515 million until May 15, 1989, to give the incoming president the opportunity to withdraw that funding if he did not want to proceed with the Space Station. Although Bush will almost certainly release the money in May, the freeze has already created minor delays in the program.

To complete the Space Station by 1998, NASA will have to receive $2 billion this year, $2.9 billion in 1990, $3.5 billion in 1991, and $3.7 billion in 1992. Without this level of support, NASA will be forced either to continue to stretch out the Station's construction schedule or cancel the program. NASA does not favor a major redesign of the Station at this late stage of its development, which would reportedly delay the Station by up to five years.

But a cut in the Space Station budget appears almost certain. "It's very likely that the Station will be cut back this year," said David Black. "It's at the point now, however, where it's either do it or don't. It would be better to fund it on time than to add costs by delaying it."

Congressional hearings on NASA's budget wrap up this spring. A decision is expected by July. □

Meade® 2080: $999 complete!

Now, for a limited time at participating Meade dealers, you can purchase the Meade 8″ Model 2080—the original *worm-gear* 8″ Schmidt-Cassegrain for the incredibly low price of $999—complete as shown, including variable height field tripod!

The Meade 2080 is a research-class instrument that incorporates features normally found only on much more expensive instruments. Consider this standard equipment listing:

☐ **Diffraction-Limited Optics**—Optics limited in performance only by the laws of physics. The same legendary f/10 optics included with Meade 8″ LX5 SCT's.

☐ **Worm-Gear Drive System (115v./60Hz)**—The Meade 2080 is the only 8″ SCT in its price class to include a large, astrophotographic-precision worm-gear drive (see photo, below)—a feature not available even optionally on competing 8″ models.

The standard-equipment worm gear drive system of the Meade Model 2080.

☐ **Equatorial Wedge**—With full 360° azimuth capability, polar elevation scale, and 8 pc. lock-knob set for quick set-up and polar alignment.

☐ **Variable-Height Field Tripod**—Rock-solid, locked-leg design; an ideal platform for either visual or sensitive long-exposure photo applications.

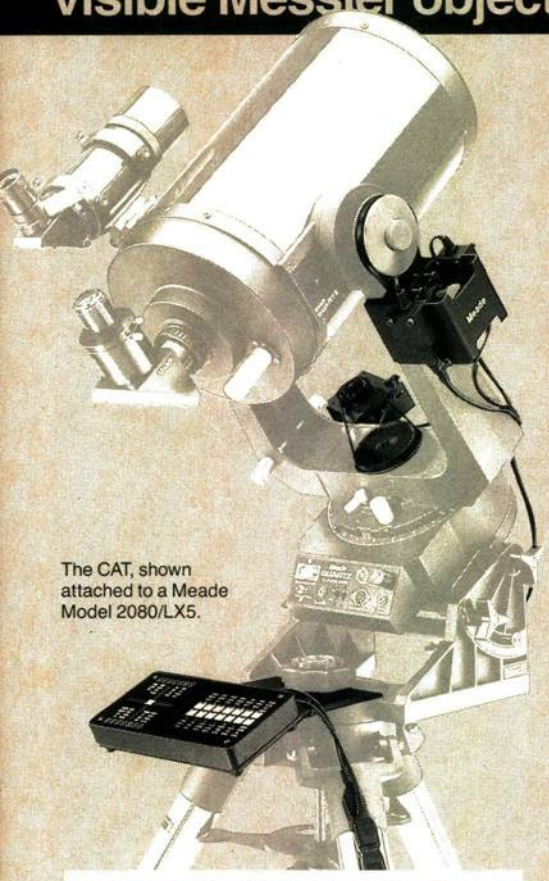
☐ **Optional Features**—Add photo-visual accessories from the longest options listing in the industry: multi-coated optics group; quartz-controlled dual-axis drive corrector; digital setting circles; the CAT computer aided telescope system; Series 4000 super wide and ultra wide angle eyepieces; and a great deal more.

☐ **Best of All**—You can purchase the complete Meade 2080, as described, for only $999 during the period of this special offer.

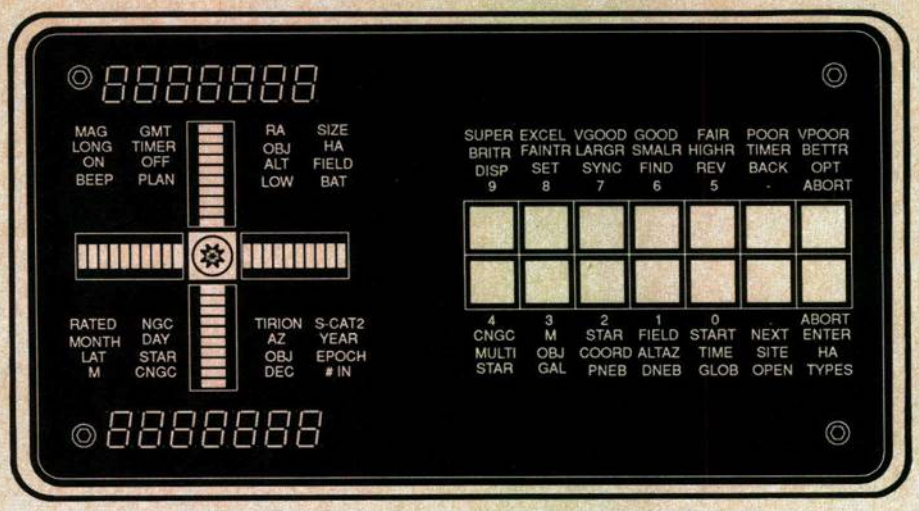
Specifications: Meade Model 2080—Includes 8″ f/10 Schmidt-Cassegrain optical tube assembly; fork mount with worm-gear motor drive system (115v./60Hz) and 6 ft. power cord; setting circles; manual slow-motion controls and locks on both axes; eyepiece-holder (1¼″); diagonal prism (1¼″); MA 25mm (80X) eyepiece; 6 x 30mm viewfinder; equatorial wedge with latitude scale and 8 pc. knob set; variable height field tripod; dust covers; instruction manual. **$999.**

Background: Meade 2080 Photos.
Top—Omega Nebula (M17)
Bottom—Trifid Nebula (M20)

Observe 100 objects per hour—including the entire listing of visible Messier objects—with the Meade® CAT™!



The CAT, shown attached to a Meade Model 2080/LX5.



The CAT display console. (Actual size: 4¼" x 7¾".)

The Meade CAT ("Computer Aided Telescope") system is a revolutionary telescope accessory that leads Schmidt-Cassegrain telescopes from object to object, *in seconds.* The graphic display on the CAT's console enables the observer to locate *any object in the CAT's 8,199-object memory within, literally, 5 to 10 seconds or less.*

How it works: Included with the CAT are 2 precision optical encoders that mount on the telescope and sense the telescope's position in RA and Dec. Using the CAT's large, red-illuminated crossline display, the observer manually moves the telescope to the position dictated by the crosslines. The CAT unerringly positions the desired object precisely in the center of the telescopic field. In addition, digital readouts on the display console continuously display R.A. and Declination.

Object Database: Included within the CAT's computer memory database are the positions of 8,199 objects—*virtually every object of interest in the entire celestial sphere, North and South:*

☐ **7,840 Deep-Space Objects,** including all 110 Messier objects, plus 7,730 other objects contained in the Computerized New General Catalog (CNGC)—galaxies, nebulae, star clusters, objects of every description in the sky.

☐ **351 Bright Stars,** used primarily as CAT reference objects, including 100 interesting double and multiple stars.

☐ **8 Major Planets:** The positions of all 8 major planets are included in the CAT's memory, a feature not available on any other computerized telescope system. In seconds you can locate Mercury, even in bright twilight; observe Uranus and Neptune; or photograph the day-to-day motion of 14th-magnitude Pluto. The CAT enables the positioning of these and the other major planets in the center of the field, easily and rapidly.

The CAT attaches in minutes to all Meade 2080- and 2120-series Schmidt-Cassegrains, and to C8 and C11 fork-mounted models as well.

Each DSC unit includes RA encoder; Dec. encoder; microprocessor control unit; readout display.

Digital Setting Circles for your Schmidt-Cassegrain!

Meade Digital Setting Circles attach to all Meade 2080- and 2120-series SCT's, and to C8 and C11 fork-mounted models. Each unit includes Hewlett-Packard optical encoders for the highest level of precision and sensitivity. The encoders attach in minutes to the polar and Dec axes. The readout unit mounts onto the telescope's rear cell, *where it is continuously visible from the eyepiece observing position as you move from object to object.*

The DSC's permit direct readout of the following information: R.A. (to a precision of 1-min.); Dec. (to 0.1°); Local Time; Sidereal Time; and a digital timer for timing photo exposures.

The DSC readout display.

New lower pricing on the Meade CAT and on Meade Digital Setting Circles is now in effect! See your Meade dealer for details.

Complete Catalog Package #89C—$3.00—Includes catalogs and bulletins on the entire range of Meade astronomical telescopes, Series 4000 eyepieces, and accessories.

Meade Instruments Corporation

World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur

1675 Toronto Way, Costa Mesa, California 92626 ☐ (714) 556-2291

©1989

IS YOUR NAME HERE?

BELOW are the names of some of the most distinguished American families. Our research staff has, over a period of years, completed a manuscript history of each of these families. If your surname is listed you should have your manuscript. We believe you will find it not only of keen interest, but a source of pride and satisfaction for yourself and your kinsmen.

THESE FAMILY HISTORIES $30.00 EACH

Each manuscript is a GENEALOGICAL and HISTORICAL study of the family from earliest times. It records the origin and growth of the family in Europe; its place among the gentry there; its part in the early settlement and subsequent history of America, including service in the Revolutionary War; and its achievements and leading representatives in this country. The derivation and meaning of the name is traced; recurrent family traits are brought out; and genealogical data on various lines are set forth. A valuable bibliography is included, as well as the authoritative description of a family coat of arms.

Each history is a separate and distinct work painstakingly compiled from the most authentic sources. Reproduced on fine paper and bound in a handsome black cover stamped in silver ink, it is suitably designed for filing among your family records or other documents.

With your order we will send *The Romance of Coats of Arms*, an informative, unique publication that is illustrated in full color. If you order promptly we will also include, at no extra cost, our specially designed Ancestry Chart. It measures 17 by 22 inches and contains spaces in which to record the names of your ancestors in all lines for eight generations.

The coupon or a letter, with $30.00 (no other charge), will bring you your manuscript, *The Romance*, and The Ancestry Chart by return mail. Satisfaction is assured by our money back guarantee. Any two manuscripts may be had for $50.00, any three for $75.00. Send for yours today. Roots Research Bureau, Ltd., 39 W. 32 Street, N.Y., N.Y. 10001.

Look Also For Your Mother's and Grandmother's Maiden Names

ABBOT(T)
ABEL(L)
ABERNATHY
ABERNETHY
ABRAHAM(S)
ABRAMS
ACHESON
AC(K)ERLY
ACKERMAN
ACKERS
ACTON
ADAIR
ADAM(S)
ADKINS
AGAR
AGER
AGNEW
AIKEN(S)
AINSWORTH
AITKEN
AKERS
ALBERT(S)
ALBRECHT
ALBRIGHT
ALDEN
ALDERMAN
ALDERSON
ALDRICH
ALDRIDGE
ALEXANDER
ALFORD
ALGER
ALLAN
ALLEN
ALLISON
ALLMAN
ALSOP
ALSTON
ALVORD
AMANN
AMBLER
AMBROSE
AMES
AMMANN
AMMON
AMOS
ANDERSON
ANDREW(S)
ANGEL(L)
ANTHONY
ANTRIM
APPLEBY
APPLEGATE
APPLETON
ARCHER
ARCH(I)BALD
ARMI(S)TEAD
ARMITAGE
ARMSTRONG
ARNDT
ARNETT
ARNOLD
ARNOTT
ARROWSMITH
ARTHUR
ASBURY
ASHBY
ASH(E)
ASHLEY
ASHTON
ASTON
ATCHISON
ATHERTON
ATKINS
ATKINSON
ATWATER
ATWELL
ATWILL
ATWOOD
AUBR(E)Y
AUSTIN
AVERELL
AVERILL
AVERY
AXTELL
AYER(S)
AYRES
BABBITT
BABCOCK
BABER
BACH(E)
BACHMAN(N)
BACON
BADCOCK
BADGER
BADGLEY
BAER
BAGGETT
BAGGOTT
BAGLEY
BAGWELL
BAILEY
BAIN-BRIDGE
BAIN(E)(N)
BAIRD
BAKER
BALCH
BALCOM(B)
BALDRIDGE
BALDWIN
BALL
BALLANTINE
BALLANTYNE
BALLARD
BALLENGER
BALLENTINE
BALLINGER
BALLOU
BAMFORD
BANCROFT
BANGS
BANISTER
BANKE(S)
BANNING
BANNISTER
BANTA
BARBEE
BARBOUR
BARCLAY
BARCROFT
BARD
BARDEN
BARDIN
BARDON
BARDWELL
BARKER
BARKLEY
BARLOW
BARNARD
BARNES
BARNET(T)
BARNEY
BARNUM
BARR
BARRELL
BARRETT
BARRINGER
BARRION
BARROW(S)
BARRY
BARTHOLOMEW
BARTLETT
BARTON
BARTOW
BASHORE
BASS(E)
BASSET(T)
BA(T)CHELDER
BA(T)CHELLER
BA(T)CHELOR
BATEMAN
BATES
BATSON
BATTEN
BATTLE(S)
BATT(S)
BAUER
BAUGH
BAUGHMAN
BAUM
BAUMAN(N)
BAXTER
BAYLE(S)
BAYLEY
BAYLIS(S)
BAYLOR
BAYNE(S)
BEACH
BEACHAM
BEAHM
BEALE
BEAL(L)
BEAM
BEAMAN
BEAN(E)
BEAR
BEARD
BEARDSLEY
BEASLEY
BEASON
BEATON
BEATTIE
BEATTY
BEAUCHAMP
BEAUMONT
BEAVER(S)
BECK
BECKER
BECKET(T)
BECKFORD
BECKHAM
BECKLEY
BECKMAN(N)
BECKWITH
BEDELL
BEDFORD
BEEBE
BEECH
BEECHER
BEEKMAN(N)
BEEM
BEEMAN
BEER(S)
BEESLEY
BEESON
BEGG
BEICHER
BELDEN
BELDING
BEL(K)NAP
BELL
BELLAMY
BELLINGER
BELLOWS
BELT
BEMIS
BENEDICT
BENHAM
BENJAMIN
BENN
BENNER
BENNETT
BENSEN
BENSON
BENT
BENTLEY
BENTON
BENTZ
BERGEN
BERGIN
BERINGER
BERK(E)LEY
BERNARD
BERRY
BERRYMAN
BERTRAM
BERTRAND
BEST
BETHUNE
BETTS
BEVAN(S)
BEVER(L)E)Y
BEYER
BIBB
BICKEL
BICKFORD
BICKLEY
BICKNELL
BIDDLE
BIDWELL
BIGELOW
BIGGER(S)
BIGG(S)
BILLINGS
BILLINGSLEY
BILLINGTON
BILL(S)
BILLUPS
BINGHAM
BINNS
BIRCH
BIRD
BIRDSALL
BIRDSELL
BISBEE
BISHOP
BISSELL
BIXBY
BLACK
BLACKBURN(E)
BLACKMAN
BLACKMORE
BLACKSTONE
BLACKWELL
BLACKWOOD
BLADE(S)
BLAIN(E)
BLAIR
BLAKE
BLAK(E)L(E)Y
BLAKEMAN
BLAKEMORE
BLAKESLEE
BLAKESLEY
BLAKEY
BLANCHARD
BLANCK
BLAND
BLANEY
BLANKENSHIP
BLANK(S)
BLANTON
BLEDSOE
BLENKINSOP
BLEW
BLIGH
BLINN
BLISS
BLODGETT
BLOOD
BLOSSOM
BL(O)UNT
BLUE
BLY(E)
BLYTH(E)
BOARDMAN
BOAZ(R)MAN
BODELL
BODLE
BOEHM
BOGARDUS
BOGART
BOGERT
BOGGS
BOGUE
BOLAND
BOLDEN
BOLLING
BOLTON
BOND
BONHAM
BONNELL
BONNER
BONN(E)Y
BOOKER
BOON(E)
BORDEN
BORN(E)
BOSS(E)
BOSTON
BOSTWICK
BOSWELL
BOSWORTH
BOTT(S)
BOUCHER
BOU(G)HTON
BOULDIN
BOURN(E)
BOWEN
BOWER(S)
BOWE(S)
BOWIE
BOWKER
BOWLBY
BOWLER
BOWLES
BOWLING
BOWMAN
BOWSER
BOWYER
BOYCE
BOYD
BOYDEN
BOYES
B(O)YINGTON
BOYLE(S)
BOYNTON
BRAC(E)(Y)
BRACKEN
BRACKETT
BRADBURN
BRADBURY
BRADFORD
BRADLEY
BRADSHAW
BRADY
BRAGDON
BRAGG
BRAHAM
BRAINARD
BRAINERD
BRAME
BRANCH
BRAND
BRAN(D)T
BRANHALL
BRANNAN
BRANNON
BRANSON
BRASHEAR(S)
BRATTON
BRAY
BRAZIER
BRECKENRIDGE
BRECKINRIDGE
BREECE
BREED
BREEN
BREESE
BREEZE
BRENNAN
BRENT
BRENTON
BRETT
BREWER
BREWSTER
BRIAN
BRICE
BRIDGE
BRIDGE(F)MAN
BRIDGES
BRIER
BRIGGS
BRIGHAM
BRIGHT
BRINCKERHOFF
BRINK
BRINTON
BRISCOE
BRISTOL
BRITT
BRITTAIN
BRITTEN
BRITTON
BROCK
BROCKETT
BRODIE
BRODY
BROMFIELD
BROMLY
BRONSON
BROOK
BROOKS
BROUGH
BROUGHTON
BRO(U)WER
BROWN(E)
BROWNELL
BROWNING
BROWNLEE
BROWNLEY
BROWNSON
BROYLES
BRUCE
BRUEN
BRUMBAUGH
BRU(N)NER
BRUNSON
BRUSH
BRYAN
BRYANT
BRYCE
BRYER
BUCHANAN
BUCHER
BUCK
BUCKINGHAM
BUCKLAND
BUCKLEY
BUCKMAN
BUCKNAM
BUCKNER
BUDD(E)
BUEL(L)
BUFFINGTON
BUFORD
BULK(E)LEY
BULL
BULLARD
BULLEN
BULLOCH
BULLOCK
BULMAN
BUNCE
BUNDE
BUNDY
BUNKER
BUNN
BUNNELL
BUNTIN
BUNTON
BURBANK
BURCH
BURCHARD
BURDETT(E)
BURFORD
BURGER
BURGESS
BURGOYNE
BURK(E)
BURLEIGH
BURLEY
BURLINGAME
BURNETT
BURNHAM
BURNS
BURR
BURRALL
BURRILL
BURRITT
BURROUGHS
BURROWS
BURT BURTON
BURWELL
BUSBY
BUSH
BUSHNELL
BUSS(E)(Y)
BUTCHER
BUTLER
BUTTERFIELD
BUTTER(S)
BUTTERWORTH
BUTTON
BUTTRICK
BUTT(S)
BUTZ
BUXTON
BYER(S)
BYRAM
BYRD
BYRNE
BYRON
BYRUM
CABELL
CABLE
CADE
CADY
CAHILL
CAIN(E)
CALDWELL
CALHOUN
CALL
CALLAHAN
CALLAWAY
CALLENDER
CALLOWAY
CALVERT
CAMERON
CAMPBELL
CAMP(E)
CANFIELD
CANNON
CANTRELL
CAPEN
CAPP(S)
CARDWELL
CAR(E)Y
CARGILL
CARHART
CARL(E)
CARL(E)TON
CARLISLE
CARLL
CARLYLE
CARMAN
CARMICHAEL
CARNES
CARNEY
CAROTHERS
CARPENTER
CARR
CARRIER
CARRINGTON
CARROLL
CARRUTHERS
CARSON
CARTER
CARTWRIGHT
CARUTHERS
CARVER
CASE
CASEY
CASKEY
CASKIE
CASS
CASSADY
CASSE(L)
CASSIDY
CASTLE
CASWELL
CATE(S)
CATLETT
CATLIN
CAULEY
CAVANA(U)GH
CAVE
CAWLEY
CECIL
CHADWICK
CHAFFEE
CHALMERS
CHAMBER(L)A)IN
CHAMBERS
CHAMPION
CHAMP(L)A)IN
CHAMBERS
CHAMPION
CHAMP(L)A)IN
CHANCE
CHANDLER
CHANEY
CHAPIN
CHAPLIN
CHAPMAN
CHAPPELL
CHARLES
CHARLTON
CHASE
CHATFIELD
CHEATHAM
CHEEK
CHEEVER(S)
CHENEY
CHENOWETH
CHERRY
CHESLEY
CHESTER
CHEVALIER
CHEW
CHICHESTER
CHICK
CHILDERS
CHILDRESS
CHILD(S)
CHILES
CHILTON
CHINN
CHIPMAN
CHISHOLM
CHITTENDEN
CHOATE
CHRIST
CHRISTIAN
CHRISTIE
CHRIS(T)MAN(N)
CHRISTMAS
CHRISTOPHER
CHRISTY
CHURCH
CHURCHILL
CHUTE
CLAFLIN
CLAIBORNE
CLAPP
CLARE
CLARK(E)
CLARKSON
CLAUSON
CLAUS(S)EN
CLAWSON
CLAY
CLAYBORN(E)
CLAYBURN
CLAYPOOL(E)
CLA(Y)SON
CLAYTON
CLE(A)VELAND
CLEAVER
CLEAVE(S)
CLEMENT(X)S)
CLEM(M)ONS
CLIFF
CLIFFORD
CLIFT
CLIFTON
CLINE
CLINTON
CLOSE
CLOUGH
COAKLE
COAN
COAT(E)S
COBB
COCHRAN(E)
COCKRELL
CODDINGTON
CODY
COE
COEN
COFFEE
COFFEY
COFFIN
COGAN
COGGESHALL
COGGIN(S)
COGSWELL
COKER
COL(L)BURN
COLBY
COLDWELL
COL(E)MAN
COLLEY
COLLIER
COLLINS
COL(S)TON
COLT
COLTON
COLVER
COLVIN
COLWELL
COMER
COMPTON
COMSTOCK
CONANT
CONDIT
CONE
CONEY
CONKLIN(G)
CONLEY
CONN
CONNELL
CONNELLY &
CONNER
CONOVER
CONRAD
CONSTANTINE
CONTEE
CONWAY
CONYERS
COOK(E)
COOKSEY
COOLEY
COOLIDGE
COO(M)BS
COON(S)
COOPER
COPE
COPELAND
COPLEY
CORBETT
CORBIN
CORDELL
CORDES
COR(E)Y
CORLEY
CORNELIUS
CORNELL
CORNISH
CORNWALL
CORNWELL
CORSON
CORWIN
COSBY
COSGROVE
COSTER
COTE
COTTER
COTTON
COTTRELL
COUCH
COULTER
COUNCIL
COURTNEY
COUSINS
COVELL
COVERT
COWAN
COWDEN
COWELL
COWEN
COWIN
COW(L)ES
COWLEY
COX(E)
COY
CRABB(E)
CRABTREE
CRADDOCK
CRAFT
CRAIG
CRAIN
CRAMER
CRANE
CRANMER
CRAVEN
CRAWFORD
CRAWLEY
CREEL
CREIGHTON
CRENSHAW
CRES(S)WELL
CREW(S)
CRICHTON
CRIPPEN
CRIST
CRISWELL
CRITTENDEN
CROCKER
CROCKETT
CROFT
CROMER
CROMWELL
CROOK(S)
CROSBY
CROSIER
CROSS
CROSS(M)AN
CROUCH
CROWDER
CROW(E)
CROWELL
CROWLEY
CROWTHER
CROXTON
CROZIER
CRUMP
CRUTCHER
CUL(B)ERSON
CULLEN
CULP
CULVER
CUMMIN(G)S
CUNNINGHAM
CURL(E)(S)
CURRIE
CURRIER
CURRY
CURTIN
CURTIS
CUSHING
CUSHMAN
CUTHBERT
CUTLER
CUTTER
CUTTING
DABNEY
DAGGETT
DAIL(E)Y
DALE
DAL(E)Y
DALRYMPLE
DALTON
DAM(E)RON
DAMON
DANA
DANE
DANFORD
DANFORTH
DANIEL(S)
DAN(N)
DARBY
DARLING
DARLINGTON
DARNALL
DARNELL
DARRA(G)H
DARROW
DART
DAUGHERTY
DAVENPORT
DAVE(Y)
DAVID(S)
DAV(I)DSON
DAVIE
DAV(I)E(S
DAWE(S)
DAWSON
DAY
DAYTON
DEAL
DEAN(E)
DEARBORN
DEARING
DECKER(T)
DEE
DE(E)R)ING
DEFOREST
DEGRAFF
DEHAVEN
DEKKER
DELAFIELD
DELAN(E)Y
DELANO
DELL
DELONG
DEMING
DEMPSEY
DENHAM
DENMAN
DENNETT
DENN(E)Y
DENNING
DENNIS
DEN(N)ISON
DENT
DENTON
DEPEW
DEPUE
DERBY
DEVEAUX
DEVERE(A)UX
DEVOE
DEW
DEWEY
DEWITT
DEWOLF(E)
DEXTER
DIBBLE
DICK(E)
DICKENS
DICKERMAN
DICKERSON
DICKEY
DICKINS
DICKINSON
DICKMAN
DICKSON
DIEHL
DIETRICH
DIGGE(E)S
DIKE
DIKEMAN
DILL
DILLARD
DILLER
DILLINGHAM
DILLON
DIM(M)ICK
DIM(M)OCK
DINSMORE
DISBROW
DIX
DIXON
DOAN(E)
DOBBS
DODD(S)
DODGE
DODSON
DOE
DOGGETT
DOHERTY
DOLE
DONAHOE
DONAHUE
DONALD
DONALDSON
DONELSON
DONNELL
DONNELLY
DONOHOE
DONOHUE
DONOVAN
DO(O)ILAN
DOOLITTLE
DORE
DOREMUS
DORMAN
DORR
DORSET(T)
DOTSON
DOTY
DOUD
DOUGHERTY
DOUGHTY
DOUGLAS(S)
DOUTHIT(T)
DOVE
DOW
DOWD
DOWELL
DOWLING
DOWNER
DOWN(E)S
DOWNING
DOYLE
DRAKE
DRAPER
DRESSER
DREW
DREWRY
DRINKWATER
DRIVER
DRUMMOND
DRURY
DRYDEN
DUBOIS
DUCKWORTH
DUDLEY
DUFF
DUFFIELD
DUFFY
DUG(G)AN
DUKE(S)
DULAN(E)Y
DUMAS
DUMONT
DUNBAR
DUNCAN
DUNHAM
DUNLAP
DUNLOP
DUNN(E)
DUNNING
DUPRE(E)
DURAND
DURANT
DURFEE
DURHAM
DURKIN
DURYEA
DUSTIN
DUTTON
DU(VAL(L)
DWIGHT
DWYER
DYCKMAN
DYE
DYER
DYK(E)MAN
DYKE(S)
DYRE
EAD(E)S
EAGER
EAMERS
EARL(E)
EARL(E)Y
EAST
EASTMAN
EASTON
EASTWOOD
EATON
EBERHAR(D)T
EBY
ECCLES
ECHOLS
ECKLES
EDDY
EDEN
EDES
EDGAR
EDGERTON
EDMONDS
EDMON(D)SON
EDMONSTON
EDMUNDS
EDSON
EDWARDS
EGGLESTON
ELDER
ELDRED(GE)
ELDRIDGE
ELIOT
ELK(N)S
ELLERY
ELLINGTON
ELLIOT(T)
ELLIS
ELL(I)SON
ELLSWORTH
ELL(I)WOOD
ELMER
ELM(E)S
ELMORE
ELWELL
ELY
EMBREE
EMBR(E)Y
EMERSON
EMERY
EMMET(T)
EMMONS
ENDICOTT
ENGEL
ENGLAND
ENGLE
ENGLISH
ENNIS
END(S)
ENSIGN
EPPS
ERSKINE
ERWIN
ESTABROOK(S)
ESTES
ETHERIDGE
EUBANK
EUSTACE
EUSTIS
EVANS
EVERARD
EVERETT
EVERHART
EVERITT
EWER(S)
EWING
FAIR
FAIRBANK(S)
FAIRCHILD
FAIRFAX
FAIRFIELD
FAI(R)LEY
FALCONER
FALES
FANCHER
FANNING
FARMER
FARN(H)AM
FARNSWORTH
FARNUM
FARQUHAR
FARR
FARRAR
FARRELL
FARRINGTON
FARIS
FARWELL
FAULKNER
FAUNCE
FAUNTLEROY
FAWCETT
FAY
FE(A)R)N(E)
FE(A)THERSTONE
FELL
FELLOWS
FELT
FELTON
FENN
FENNER
FENTON
FENWICK
FERGUSON
FERNALD
FERRELL
FERRIS
FESSENDEN
FIELDING
FIEL(D)S
FIFE
FILLEY
FIN(D)LAY
FIN(D)LEY
FINNEY
FISH
FISHER
FISK(E)
FITCH
FITTS
FITZ
FITZGERALD
FITZHUGH
FITZPATRICK
FLAGG
FLANAGAN
FLANDERS
FLANIGAN
FLE(I)S(C)HER
FLEM(M)ING
FLETCHER
FLINN
FLINT
FLOOD
FLORY
FLOURNOY
FLOWER(S)
FLOYD
FLYNN
FOLEY
FOLGER
FOLK(S)
FOLLET(T)
FOLSOM
FONES
FONTAINE
FOOTE
FORBES
FORCE
FORD
FOR(E)MAN
FORREST
FO(R)STER
FORSYTH(E)
FORT(E)
FOSS
FOULK(E)(X)S)
FOUNTAIN
FOWLER
FOW(L)KES
FOX
FOY
FRAME
FRANCE
FRANCIS
FRANK(E)
FRANKLIN
FRAN(T)Z
FRASER
FRAZEE
FRAZ(I)ER
FREAR
FRED(E)RICK
FREELAND
FREEMAN
FREER
FREES(E)
FRENCH
FREY
FRIEND
FRIES(E)
FRISBIE
FRISBY
FROST
FRY(E)
FRYER
FULCHER
FULLER
FULLERTON
FULTON
FUN(C)K(E)
FURMAN
FYFE
GAGE
GAILLARD
GAINES
GALBRAITH
GALBREATH
GALE
GALL(A)G)HER
GALL(E)
GALLOP
GALLOWAY
GALLUP
GAMBLE
GARARD
GARBER
GARD(I)NER
GARFIELD
GARLAND
GARNER
GARNET(T)
GARRETT
GARRISON
GARTH
GARVEY
GARVIN
GARY
GASKINS
GASTON
GATES
GA(U)LT
GAY
GAYLORD
GEAR
GEARY
GEDNEY
GEE
GEER
GENTRY
GEORGE
GERARD
GERBER
GERHAR(D)(X)T)
GERMAN
GERRY
GIBBON(S)
GIBBS
GIBSON
GIDDINGS
GIFFORD
GILBERT
GILCHRIST
GILE(S)
GILL
GILLESPIE
GILLET(T)(X)E)
GILL(I)AM
GILL(I)E)S
GILL(L)MAN
GILMER
GILMORE
GILMOUR
GILPIN
GILSON
GIRARD
GIVEN
GLADDEN
GLAD(D)ING
GLASCOTT
GLASGOW
GLASS
GLAS(S)COCK
GLEASON
GLEESON
GLEN(N)
GLIDDEN
GLOVER
GLYNN
GOBLE
GODDARD
GODFREY
GOFF(E)
GOLDING
GOLDSBOROUGH
GOLDSMITH
GOOCH
GOODALL
GOOD(E)
GOODELL
GOODENOUGH
GOOD(E)NOW
GOODING(G)
GOODMAN
GOODRICH
GOODRIDGE
GOOD(W)IN
GOODYEAR
GORDON
GORE
GORHAM
GORTON
GOSS(E)
GOUGH
GOULD
GOULDING
GOVER
GOWER
GRACE
GRAHAM
GRANGER
GRANT
GRATTAN
GRAVES
GRAY
GRAYSON
GREAR
GREEL(E)Y
GREEN(E)
GREENHALGH
GREENLEAF
GREENLEE
GREENOUGH
GREENWELL
GREENWOOD
GREER
GREGG
GREGORY
GRESHAM
HAZ(Z)ARD
HEAD
GRIDLEY
GRIER
GRIFFEN
GRIFFITH
GRIGG(S)
GRIGSBY
GRIMES
GRINDLE
GRINNELL
GRISWOLD
GROSS(E
GROSVENOR
GROTE
GROUT
GROVE
GROVER
GROVES
GROW
GRUB(B)E
GRUBB(S)
GRYMES
GU(E)NT(H)ER
GUEST
GUILD
GUILE
GUION
GULICK
GUNN
GUNNELL
GURLEY
GURNEY
GUTHRIE
GUY
GUYON
GWINN
GWYNN
GYLES
HACKER
HACKETT
HADDEN
HADDOCK
HADLEY
HA(E)GER
HAF(F)NER
HAGAN
HAGEMAN(N)
HAGEN
HAGERMAN(N)
HAGGARD
HAGUE
HAHN
HAIG(H)
HAINES
HAIR(E)
HAIRSTON
HALE
HALL
HALLAM
HALLECK
HALLENBECK
HALLET(T)
HALLEY
HALLIDAY
HALLOCK
HALLOWELL
HALSEY
HALSTE(A)D
HAMER
HAMILL
HAMILTON
HAMLIN
HAM(M)
HAM(M)EL
HAMMETT
HAMMOND
HAMPTON
HANCE
HANCOCK
HAND
HAND(I)LEY
HANDY
HANEY
HANK(E)(X)S)
HANK(N)S)
HANMER
HANMORE
HANN
HANNA(H)
HANNAY
HANSEN
HANSON
HARBAUGH
HARDEN
HARDIE
HARDI(M)AN
HARDIN
HARDING
HARDWICK(E)
HARDY
HARE
HARGR(E)AVE(S)
HARKER
HARKNESS
HARLAN
HARLEY
HARLOW
HARMAN
HARMER
HARMON
HARPER
HARRIMAN
HARRINGTON
HARRIS
HARRISON
HAR(R)OLD
HARRY
HART
HARTLEY
HARTSHORN(E)
HARTWELL
HARVEY
HARWOOD
HASBROUCK
HASKELL
HASK(N)S)
HASSARD
HASTINGS
HATCH
HATCHER
HATCHETT
HATFIELD
HATHAWAY
HATTON
HAUG(E)MAN(N)
HAUSER
HAVILAND
HAWES
HAW(K)E)(X)S)
HAWKINS
HAWLEY
HAWORTH
HAWTHORNE
HAY
HAYDEN
HAY(E)S
HAYMAN
HAYNES
HAYWARD
HAYWOOD
HAZEN
HAZ(Z)ARD
HEAD

HEADLEY
HEALD
H(E)AL(E)Y
HEARD
HEARN(E)
HEATH
HEATON
HEBB
HEBERT
HEDGE(S)
HEDRICK
HEF(F)NER
HEGEMAN
HELLER
HELM
HENDERSON
HEN(D)LEY
HENDRICK(S)
HENDRIX
HENKEL
HENKLE
HENNING
HENRY
HENSLEY
HEPBURN
HERBERT
HERMAN
HERNDON
HERRICK
HER(R)ING
HERRINGTON
HER(R)ON
HERSEY
HERSHEY
HESS(E)
HEWES
HEWETT
HEWITT
HEWLETT
HEYMAN
HEYWOOD
HIATT
HIBBARD
HIBBERT
HICKEY
HICKMAN
HICKOK
HICKS
HIGDON
HIGGINBOTHAM
HIGGINS
HIGHLAND
HIGHT
HIGLEY
HILDRETH
HILLIARD
HILLIER
HILLMAN
HILL(S)
HILLYER
HILTON
HIN(C)KLEY
HIND(S)
HINE(S)
HINKLE
HINMAN
HINTON
HITCH
HITCHCOCK
HITE
HOAG
HOAGLAND
HOAR(E)
HOBART
HOBBS
HOBSON
HOCH
HODGE(S)
HODGKINS
HODGSON
HOFF
HOF(F)MAN(N)
HOGAN
HOGG
HOG(U)E
HOIT
HOLBROOK
HOLCOMB(E)
HOLDEN
HOLDER
HOLLAND
HOLLENBECK
HOLL(E)Y
HOLLIDAY
HOLLIN(G)SHEAD
HOLLINGSWORTH
HOLLIS
HOLLISTER
HOLLOWAY
HOLLOWELL
HOLMAN
HOLMES
HOLT
HOLTON
HOLYOKE
HOMER
HOOD
HOOK
HOOKER
HOOPER
HOOVER
HOPE
HOPKINS
HOPPER
HOPSON
HORN(E)
HORNER
HORS(L)EY
HORTON
HOSKIN(S)
HOSMER
HOTCHKISS
HOUGH
HOUGHTON
HOUSE
HOUSEMANN
HOUSER
H(O)USTON
HOWARD
HOW(E)
HOWELL
HOWES
HOWLAND
HOWLETT
HOY(E)
HOYT
HUBBARD
HUBBELL
HUBER
HUBERT
HUCK
HUDDLESTON
HUDGINS
HUDSON
HUFF
HUGGINS
HUGHES
HULL
HUME(S)
HUMPHREY(S)
HUMPHRIES
HUNDLEY
HUNGERFORD
HUNT
HUNTER
HUNTINGTON
HUNTLEY
HURD
HU(R)LBU(R)T
HURLEY
HURST
HUSBAND(S)
HUSSEY
HUTCHE(R)SON
HUTCHIN(G)S
HUTCHI(N)SON
HUTTER
HUTTON
HYATT
HYDE
HYETT
HYLAND
IDE
INGALL(S)
INGE
INGERSOLL
INGHAM
INGLIS
INGRA(HA)M
INNES
INNIS
IRBY
IRELAND
IRISH
IRVIN(E)
IRVING
IRWIN
ISAAC(S)
ISBELL
ISHAM
IVES
IV(E)Y
IVINS
JACKMAN
JACK(S)
JACKSON
JACOB(S)
JACQUES
JA(E)GER
JAMES
JAM(I)(E)SON
JANES
JANSON
JANS(S)EN
JAQUES
JARMAN
JARRETT
JARVIS
JAY(E)
JEFF(E)RIES
JEFFERSON
JEFFERY(S)
JEFFREY(S)
JEN(C)K(E)S
JENKIN(S)
JENN(E)Y
JENNINGS
JERMAN
JESSUP
JETT
JEWELL
JEWETT
JOB(E)
JOHN(S)
JOHNSON
JOHNSTON(E)
JOINER
JOLL(E)Y
JOLLIFFE
JONES
JORDAN
JORDON
JOSLIN
JOSLYN
JOY
JOYCE
JOYNER
JUDD
JUDKINS
JUDSON
JUDY
JULIAN
JULIEN
JUSTICE
KA(I)N(E)
KAISER
KARL
KATES
KAVANA(U)GH
KAY(E)
KEANE
KEARNEY
KEARNS
KEATING
KEATON
KEELER
KEEL(E)Y
KEELING
KEENAN
KEEN(E)
KEENEY
KEEP
KEHOE
KEIL
KEISER
KEITH
KELLAR
KELLER
KELL(E)Y
KELLOGG
KELSEY
KELSO
KEMP(E)
KEMPER
KENAN
KENDALL
KENDRICK
KENNARD
KENNEDY
KENN(E)Y
KENNON
KENT
KENYON
KEO(U)GH
KERBY
KERN
KERNS
KERR
KERSHAW
KERWIN
KETCHAM
KETCHUM
KEY(E)
KEY(E)S
KEYSER
KIDD
KIDDER
KILBO(U)RN(E)
KILBURN
KILGORE
KILHAM
KILLAM
KILMER
KILPATRICK
KIMBALL
KIMBERLY
KIMBLE
KINCADE
KINCAID
KINCHELOE
KINDER
KING
KINGMAN
KINGSBURY
KINGSLEY
KINGSTON
KINKADE
KINKAID
KINKEAD
KINNEY
KINSELLA
KINSLEY
KIPP
KIRBY
KIRK
KIRKHAM
KIRKLAND
KIRKPATRICK
KIRKWOOD
KIRWAN
KISER
KITCHEN
KITCHIN
KITTLE
KITTREDGE
KLINE
KNAPP
KNICKERBOCKER
KNIGHT
KNIGHTON
KNOTT(S)
KNOWLES
KNOWLTON
KNOX
KOLB
KRAMER
KRAUSE
KRAUS(S)
KUHN(S)
KULP
KUNKEL
KUR(T)Z
KYLE
LAC(E)Y
LADD
LAFFERTY
LAFORGE
LAIRD
LAKE
LAMB
LAMBERT
LAMONT
LAM(P)KIN
LAMSON
LANCASTER
LANCE
LAND(E)
LANDER(S)
LANDES
LANDIS
LANDON
LANE
LANG
LANGDON
LANGFORD
LANGHAM
LANGLEY
LANGSTON
LANGTRY
LANHAM
LANIER
LAN(N)ING
LANTZ
LAPHAM
LAPORTE
LARKIN(S)
LARNED
LARUE
LASHER
LATHAM
LATHROP
LATIMER
LAUDER
LAUER
LAUGHTON
LAVENDER
LAWLER
LAWLOR
LAWRENCE
LAW(S)
LAWSON
LAWTON
LAWYER
LAY
LAYMAN
LAYTON
LEA
LEACH
LEADBETTER
LEAR
LEARNED
LEARY
LEATHERMAN
LEATHERS
LEAVER
LEAVITT
LECOM(P)TE
LECONTE
LEDBETTER
LEE
LEECH
LEEDS
LEEMAN
LEEPER
LEESON
LEFE(B)VRE
LEFEVOUR
LEFTWICH
LEGG(E)
LEGGETT
LEHMAN(N)
LEIGH
LEIGHTON
LEITH
LEITNER
LELAND
LEMAN
LEMLEY
LEMMON
LEMON
LENARD
LENNON
LEN(N)OX
LENT
LEN(T)Z
LENZ
LEONARD
LEROUX
LEROY
LESLEY
LESLIE
LESTER
LEVER
LEVIS
LEVITT
LEWIS
LEY
LIDDELL
LIDDLE
LIGGETT
LIGHT
LIGHTFOOT
LIGHTNER
LILL(E)Y
LILLIE
LINCK
LINCOLN
LIND(E)
LINDLEY
LINDSAY
LINDSEY
LINE
LING
LINK(E)
LINN(E)
LINTON
LIPPINCOTT
LIPPITT
LISLE
LISTER
LITCHFIELD
LITTELL
LITTLE
LITTLEFIELD
LITTLETON
LIVINGSTON
LLEWELLYN
LLOYD
LOCK(E)
LOCKETT
LOCKHART
LOCKWOOD
LODGE
LOGAN
LOHMAN(N)
LOMAS
LOMAX
LOMBARD
LONDON
LONG
LONGLEY
LOOMIS
LOONEY
LORD
LOTHROP
LOTT
LOUDEN
LOUDON
LOUNSBURY
LOVE
LOVEJOY
LOVELACE
LOVELL
LOVETT
LOVING
LOWDEN
LOW(E)
LOWELL
LOWERY
LOWR(E)Y
LOWTHER
LOYD
LUCAS
LUCE
LUCKETT
LUCK(E)(Y)
LUCY
LUDDEN
LUDLAM
LUDLOW
LUDLUM
LUDWIG
LUKE
LUKEN(S)
LUM(B)
LUMLEY
LUMPKIN
LUND
LUNDY
LUNSFORD
LUNT
LUSK
LUTHER
LUTZ
LYFORD
LYLE(S)
LYMAN
LYNCH
LYND(E)
LYNE
LYNN(E)
LYON
LYONS
MAAS
MABEE
MABIE
MABR(E)Y
M(A)CARTHUR
MACAULAY
M(A)CCLINTOCK
M(A)CCORKLE
M(A)CDONALD
M(A)DOUGAL(L)
M(A)CFADDEN
M(A)CFARLAND
M(A)CFARLANE
M(A)CGREGOR
MAC(I)E
MACK
M(A)CKAY
M(A)CKENZIE
M(A)CKINNON
M(A)CLAREN
M(A)CLAUGHLIN
M(A)CLEAN
M(A)CLEOD
M(A)CMAHON
M(A)CMANUS
M(A)CMILLAN
M(A)CMULLEN
M(A)CMURRAY
M(A)CNAB(B)
M(A)CNAMARA
MACON
M(A)CPHERSON
M(A)CRAE
M(A)CVEIGH
MADDEN
MADDOCK
MADDOX
MADDUX
MADER
MADISON
MAGEE
MAGILL
MAGOON
MAGRUDER
MAGUIRE
MAGY
MAHER
MAHON
MAHON(E)Y
MAIN
MAITLAND
MAJOR
MALCOLM
MALLET(T)(E)
MALLORY
MAL(L)OY
MALONE(Y)
MANCHESTER
MANDEVILLE
MANEY
MANL(E)Y
MANN
MANNING
MANSELL
MANSFIELD
MANSON
MAPES
MAPLE(S)
MAR(A)BLE
MARBURY
MARCH
MARCHANT
MARCY
MARDEN
MARION
MARKEY
MARKHAM
MARKLEY
MARK(S)
MARLEY
MARR
MARRIOTT
MARSH
MARSHALL
MARSTON
MARTIN
MARVEL
MARVIN
MASON
MASSEY
MASSIE
MASTER(S)
MASTERSON
MATHER
MATHE(W)SON
MAT(T)(E)SON
MAT(T)HEW(S)
MATTOCKS
MATTOX
MAUPIN
MAXCY
MAXEY
MACFIELD
MAX(S)ON
MAXWELL
MAY
MAYBERRY
MAYER
MAY(E)S
MAYHEW
MAYNARD
MAYO
MCADAM(S)
MCAFEE
MCALLISTER
MCALPIN(E)
MCAVOY
MCBRIDE
MCCABE
MCCALL
MCCALLUM
MCCART(H)Y
MCCLAIN
MCCLELLAN(D)
MCCLINTIC
MCCLOUD
MCCLUNG
MCCLURE
MCCOLLUM
MCCORD
MCCORMACK
MCCORMICK
MCCOY
MCCRARY
MCCRAY
MCCREA
MCCREADY
MCCREARY
MCCREERY
MCCRORY
MCCUE
MCCUEN
MCCULLOUCH
MCCULLOUGH
MCCUNE
MCCURDY
MCCUTCHEON
MCDANIEL(S)
MCDERMOTT
MCDONOUGH
MCDOWELL
MCELROY
MCEVOY
MCEWAN
MCEWEN
MCGEE
MCG(E)HEE
MCGHIE
MCGILL
MCGINNIS
MCGOWAN
MCGOWEN
MCGRATH
MCGRAW
MCGREW
MCGRUDER
MCGUIRE
MCHENRY
MCHUGH
MCILVAIN(E)
MCINTIRE
MCINTOSH
MCINTYRE
MCKEAN
MCKEE
MCKEEN
MCKENNA
MCKIM
MCKINLAY
MCKINLEY
MCKINNEY
MCKINNON
MCKINSTRY
MCLAIN
MCLANE
MCLELLAN
MCMASTER(S)
MCNAIR
MCNALLY
MCNAUGHTON
MCNEAL
MCNEIL(L)
MCNULTY
MCNUTT
MCQUEEN
MCSWEENEY
MCVAY
MCVEY
MCVICKAR
MCVICKER
MEACHAM
MEAD(E)
MEADOW(S)
MEANS
MEARS
MEEKER
MEEK(S)
MEERS
MEIGS
MELCHER
MELCHIOR
MELLEN
MELLER
MELIN
MELLON
MELLOR
MELTON
MELVILLE
MELVIN
MENDENHALL
MERC(I)ER
MEREDITH
MER(R)IAM
MERRICK
MERRILL
MERRIMAN
MERRITT
MERRY
MESSENGER
MESSER
MESSINGER
METCALF(E)
MEYER(S)
MICHAEL
MICKLE
MIDDLETON
MILES
MILLAR
MILLARD
MILLER
MILLET(T)
MILLIGAN
MILLIKEN
MILLS
MILNER
MILTON
MINER
MINOR
MINTER
MITCHEL(L)
MITTEN
MITTON
MINER
MINOR
MINTER
MITCHEL(L)
MITTEN
MITTON
MOBERL(E)Y
MOBLEY
MOCK
MOFFAT(T)
MOFFETT
MOFFITT
MOHR
MOHUN
MOLLOY
MOLONEY
MOLYNE(A)UX
MONK
MONROE
MONSON
MONTAGUE
MONTEITH
MONTGOMERY
MOODY
MOON(E)
MOONEY
MO(O)RE
MO(O)R(E)HOUSE
MOORHEAD
MO(O)RMAN
MOREY
MORGAN
MORIAR(I)TY
MORLEY
MORRELL
MORRILL
MORRIS
MORRISON
MORROW
MORSE
MORTIMER
MORTON
MOS(E)LEY
MOSES
MOSHER
MOS(I)ER
MOSS(E)
MOTHERSHEAD
MOTLEY
MOTT
MOULTON
MOWER
MOWRY
MOYER
MU(E)LLER
MUIR
MULFORD
MULLEN
MULLIGAN
MULLIN(S)
MULLOY
MUMFORD
MUND(A)Y
MUNK
MUNN
MUNRO(E)
MUNSELL
MUNSON
MURCHISON
MURDOCH
MURDOCK
MURPHY
MURRAY
MUSE
MUSSELMAN
MYER(S)
MYLES
NAGEL
NAGLE
NANCE
NAPIER
NASH
NASON
NAYLOR
NEAL(E)
NEAL(L)(E)Y
NEEDHAM
NEFF
NEIL(L)
NE(I)LSON
NESBIT
NETTLETON
NEUMAN
NEVILLE
NEVINS
NEVIUS
NEWBERRY
NEWBY
NEWCOMB
NEWELL
NEWHALL
NEWKIRK
NEWLAND
NEWLIN
NEWMAN
NEWTON
NICHOLAS
NICHOL(L)S
NICHOLSON
NICKERSON
NIGHTINGALE
NILES
NISBET
NIXON
NOBLE
NOEL
NOLAN
NORMAN
NORRIS
NORTH
NORTHROP
NORTHRUP
NORTON
NORWOOD
NOTT
NOTTINGHAM
NOWELL
NOYES
NUGENT
NUN(N)
NUTT
NYE
O'BRIAN
O'BRYAN
O'CONNOR
O'HAIR
O'HARA
O'HARE
O'LEARY
O'NEAL
O'NEIL(L)
O'ROURKE
O'SULLIVAN
OAK(E)S
OAKLEY
OATES
ODELL
OGDEN
OGILVIE
OGLE
OGLESBY
OLCOTT
OLDHAM
OLDS
OLIVER
OLMSTE(A)D
OLNEY
ORCHARD
ORDWAY
ORME(S)
ORMSBY
ORR
ORT(H)
ORTON
OSBORN(E)
OSGOOD
OSMAN
OSWALD
OTIS
OTT
OVERTON
OWEN(S)
PACE
PACK
PACKARD
PACKER
PADDOCK
PADGETT
PAGE
PAIGE
PAIN(E)
PAINTER
PALMER
PANNELL
PARDEE
PARDOE
PARHAM
PARKER
PARK(E)(S)
PARKHURST
PARKINSON
PARKMAN
PARMELEE
PARNELL
PARR
PAR(R)IS
PAR(R)ISH
PARROTT
PARRY
PARSONS
PARTRIDGE
PASC(H)AL
PATE
PATRICK
PATTEN
PAT(T)ERSON
PAT(T)ON
PAUL
PAUL(E)Y
PAULI
PAXSON
PAYNE
PAYNTER
PAYTON
PEABODY
PEACOCK
PEAK(E)
PEAL
PEARCE
PEARL
PEARSE
PEARSON
PEASE
PEAT
PECK
PECKHAM
PEEBLES
PEEK
PEEL
PEET
PEIRCE
PELHAM
PEMBERTON
PENCE
PENDLETON
PENICK
PENN
PENNELL
PENN(E)Y
PENNINGTON
PENNOCK
PENROSE
PENTZ
PEP(P)IER
PERCIVAL
PERCY
PERDUE
PERKINS
PERRIN(E)
PERRY
PERSON(S)
PETER(S)
PETERSEN
PETERSON
PETTIS
PET(T)IT
PETTUS
PETTY
PEYTON
PFEIF(F)ER
PHELPS
PHILBRICK
PHIL(L)IPS
PHINNEY
PHIPPS
PIC(K)ARD
PICKEL
PICKENS
PICKERING
PICKET(T)
PICKLE(S)
PIDGEON
PIERCE
PIERSON
PIGGOT(T)
PIKE
PILCHER
PILKINGTON
PILLSBURY
PINCKNEY
PINE
PINKERTON
PINNEY
PIPER
PITCHER
PIT(T)MAN
PITT(S)
PLACE
PLANT
PLATT
PLEASANT(S)
PLUM(B)
PLUM(M)ER
PLUNKETT
POE
POGUE
POINDEXTER
POLAN(D)
POLK
POLLARD
POLLEY
POLLOCK
POMEROY
POND
POOL(E)
POOR(E)
POPE
PORTER
POSEY
POST
POTTER
POTT(S)
POUND
POWELL
POWER(S)
PRATT
PRAY
PREBLE
PRENDERGAST
PRENTICE
PRENTIS(S)
PRESCOTT
PRESTON
PRETTYMAN
PREWITT
PRICE
PRIEST
PRIME
PRIM(M)
PRINCE
PRINDLE
PRINGLE
PRIOR
PRI(T)CHARD
PRITCHETT
PROBST
PROCTER
PROCTOR
PROSSER
PROUT(Y)
PRUETT
PRUITT
PRYOR
PUGH
PULLEN
PULLEY
PUMPHREY
PURCELL
PURDY
PURSELL
PURVES
PURVIS
PUSEY
PUTNAM
PYLE
PYNE
QUACKENBOS
QUACKENBUSH
QUARLES
QUICK
QUIGLEY
QUIMBY
QUINBY
QUIN(N)
QUISENBERRY
RAAB
RABB
RABE
RADCLIFF(E)
RADFORD
RAE
RAGLAND
RAILEY
RAINES
RAINEY
RALEIGH
RALEY
RALPH
RALSTON
RAMAGE
RAMBO
RAMSAY
RAMSDELL
RAMSDEN
RAMSEY
RAND
RANDALL
RANDOLPH
RANGER
RANKIN
RANNEY
RANSOM
RANSON
RAPP
RATCLIFF(E)
RATH
RATHBONE
RATHBUN
RATHBURN
RAU(S)CH
RAWL(E)S
RAWLIN(G)S
RAWSON
RAY
RAYMOND
RAYNER
RAYNOR
REA
READ
READER
READING
READY
RE(A)GAN
REAM
REARDON
REAVES
RECTOR
REDD
RED(D)ING
RED(D)INGTON
REDDY
REDFIELD
REDMAN
REDMON(D)
REECE
REED
REEDER
REEDY
REES(E)
REEVE(S)
REICHENBACH
REID
REIDY
REIF(F)
REILLY
REINHAR(D)(T)
REITER
REMICK
REMINGTON
RENARD
RENAUD
RENFRO
REN(N)ICK
REVEL(L)
REYNOLDS
RHEA
RHO(A)D(E)S
RICE
RICH
RICHARD
RICHARDS
RICHARDSON
RICHMAN
RICHMOND
RICHTER
RICKARD(S)
RI(C)KER
RICKETTS
RICKMAN
RICKS
RIDDELL
RIDDICK
RIDDLE
RIDER
RIDGEL(E)Y
RIDG(E)WAY
RIDLEY
RIEHM
RIFE
RIGBY
RIGGS
RIGHTER
RILEY
RINEHART
RING
RIORDAN
RIPLEY
RI(T)CHEY
RI(T)CHIE
RITTENHOUSE
RITTER
RIVERS
RIX
ROACH
ROAN(E)
ROBB
ROB(B)IN(S)
ROBE(R)SON
ROBERTS
ROBERTSON
ROB(E)Y
ROBIE
ROBINS
ROBINSON
ROB(I)SON
ROCHESTER
ROCHFORD
ROCK(E)
ROCKEFELLER
ROCKWELL
ROCKWOOD
RODDY
RODGERS
RODMAN
ROE
ROEBUCK
ROGERS
ROHR(ER)
ROLFE
ROLLINS
ROLLO
ROLSTON
ROOD
ROOK(E)
ROOKS
RO(O)NEY
ROOT
ROPER
ROSE
ROSS
ROSSER
ROSSITER
ROTH(E)
ROTHWELL
ROUND(S)
ROUN(D)TREE
ROURKE
ROUS(E)
ROUTH
ROWAN
ROWE
ROWELL
ROWLAND
ROWLETT
ROWLEY
ROY
ROYAL(L)
ROYCE
ROYER
ROYLE
ROYSTER
ROYSTON
RUCKER
RUDD
RUDE
RUDOLPH
RUDY
RUFFIN
RUGGLES
RUNKEL
RUNKLE
RUNYAN
RUNYON
RUPP
RUSH
RUSS
RUSSEL(L)
RUST
RUTH
RUTHERFORD
RUTLEDGE
RUTTER
RYALL
RYAN
RYDER
RYERSON
SABIN
SACKETT
SADLER
SAGE
SAGER
SALE(S)
SALISBURY
SALTER
SAM(P)SON
SAMUEL(S)
SANBORN
SANDERSON
SAND(S)
SANFORD
SANGER
SARGENT
SATTERLEE
SAUER
SA(U)NDERS
SAVAGE
SAVIER
SAWYER
SAXON
SAXTON
SAY
SAYER(S)
SAYLES
SAYRE
SCALES
SCARB(O)ROUGH
SCARLETT
SCHA(E)F(F)ER
S(C)HELL
SCHEN(C)K
S(C)HERER
SCHMID(T)
SCHMIT(T)
SCHNEIDER
SC(H)OFIELD
SCHOOLEY
SCHOTT
SCHRADER
SCHRECK
SCHRO(E)DER
SCHROETER
SCHUBERT
S(C)HULER
S(C)HULTZ
SCHUMACHER
SCHUMAN(N)
SCHURMAN
SCHUSTER
SCHUTT(E)
SCHUYLER
SCHWAB
SCHWAR(T)Z
SCOTT
SCOVIL(L)(E)
SCRIBNER
SCRUGGS
SCUDDER
SCULL
SEAGER
SEAL(S)
SEAMAN
SEARCY
SEARL(E)(S)
SEARS
SEATON
SEAVER
SEAVERNS
SEAY
SEBASTIAN
SEDGWICK
SEEBER
SE(E)GER
SEEL(E)Y
SE(E)VER
SEIBERT
SEIBOLD
SEID(E)L
SEITZ
SELBY
SELDEN
SELDON
SELF
SELLECK
SELLERS
SELL(S)
SEMPLE
SERGEANT
SETTLE
SEVERANCE
SEVERN(S)
SEVIER
SEWALL
SEWARD
SEWELL
SEXTON
SEYBOLD
SEYMOUR
SHACKELFORD
SHAF(F)ER
SHANAHAN
SHANK(S)
SHARP(E)
SHATTUCK
SHAW
SHAY
SHEA
SHEAHAN
SHEARER
SHEEHAN
SHEFFIELD
SHELDON
SHELL(E)Y
SHELTON
SHEPHERD
SHEP(P)ARD
SHERIDAN
SHERIFF
SHERMAN
SHERRILL
SHERWIN
SHERWOOD
SHIELD(S)
SHINN
SHIPLEY
SHIPMAN
SHIRLEY
SHOEMAKER
SHREVE
SHUMAN
SI(E)BER(T)
SIEBOLD
SIKES
SILVESTER
SIM(M)ON(S)
SIM(M)S
SLADE
SMART
SNIDER
SNOW
SNOWDEN
SNYDER
SOM(M)ERVILLE
SOPER
SOULE
SOUTHWELL
SOUTHWORTH
SPAFFORD
SPANGLER
SPARK(S)
SPARROW
SPA(U)LDING
SPEAR(S)
SPEED
SPEER
SPEL(L)MAN
SPENCE
SPENCER
SPENGLER
SPERRY
SPICER
SPIER(S)
SPIL(L)MAN
SPOFFORD
SPOONER
SPOTSWOOD
SPRAGUE
SPRATT
SPRINGER
SPROAT
SPROUL(E)
SPROWL
SQUIER(S)
SQUIRE(S)
STAAT(S)
STACKHOUSE
STACKPO(O)LE
STACY
STAFFORD
STAGG
STALEY
STALLINGS
STANDISH
STANFIELD
STANFORD
STANLEY
STANTON
STAPLES
STAPLETON
STARK(E)(S)
STARKEY
STAR(R)
STARRETT
STAUFFER
STCLAIR
STEAD
STE(A)DMAN
STEARN(S)
STEBBINS
STEED
STEEL(E)
STEEN
STEER(E)
STEERS
STEINER
STEPHEN
STEPHENS
STEPHENSON
STERLING
STERN(E)
STERRETT
STETSON
STEVENS
STEVENSON
STEWARD
STEWART
STICKNEY
STILES
STILL(E)
STILLMAN
STIL(L)WELL
STILSON
STIM(P)SON
STINSON
STIRLING
STJOHN
STOCKER
STOCKING
STOCKMAN
STOCK(S)
STOCKTON
STOCKWELL
STODDARD
STOKES
STONE
STONER
STORER
STOR(E)Y
STORM
STOTT(S)
STOUFFER
STOUT
STOW(E)
STOWELL
STRAIGHT
STRANGE
STRATTON
STREATOR
STREET
STREETER
STRICKER
STRICKLAND
STRINGER
STRONG
STROUD
STRYKER
STUART
STUBBS
STUMP(E)
STUMP(F)
STURGES
STURGIS
STYLES
SULLIVAN
SUMMER(S)
SUMNER
SUNDERLAND
SUT(C)LIFF(E)
SUTHERLAND
SUT(T)ER
SUTTON
SWALLOW
SWAN(N)
SWAYNE
SWEEN(E)Y
SWEET
SWETT
SWIFT
SWOPE
SYKES
SYLVESTER
SYM(M)ES
SYMON(D)S
TABER
TABOR
TAFT
TAGGART
TAIT
TALBOT(T)
TALCOTT
TALIAFERRO
TALL(E)Y
TAL(L)MA(D)GE
TAL(L)MAN
TANNER
TARBOX
TATE
TATHAM
TATUM
TAYLOR
TEAGUE
TE(E)TER
TELLER
TEMPLE
TEMPLETON
TENNANT
TENN(E)Y
TENNISON
TENNYSON
TERRELL
TERRILL
TERRY
THARP(E)
THA(T)CHER
THAYER
THOMAS
THOMAS(S)ON
THOM(E)
THOM(P)SON
THOMS
THORN(E)
THORNHILL
THORP(E)
THRASHER
THROCKMORTON
THURMAN
THURSTON
TIBBET(T)S
TIBBIT(T)S
TIFFANY
TILDEN
TILGHMAN
TILLEY
TILLMAN
TILLOTSON
TILSON
TILTON
TINDALL
TINKER
TINSLEY
TIPTON
TISON
TITUS
TOB(E)Y
TOBIN
TODD
TOLMAN
TOLSON
TOMLINSON
TOM(P)KINS
TOPPING
TORREY
TOTTEN
TOWER(S)
TOWLE(S)
TOWNE
TOWNLEY
TOWNSEND
TRAC(E)Y
TRASK
TRAVER(S)
TRAVIS
TRE(A)DWELL
TREAT
TREMAINE
TRENT
TRIGG(S)
TRIPLETT
TRIPP
TROTT
TROTTER
TROUT
TROWBRIDGE
TRUAX
TRUE
TRU(E)MAN
TRUESDALE
TRUESDELL
TRUEX
TRUMBULL
TRYON
TUBBS
TUCK
TUCKER
TUDOR
TUFTS
TULLOCH
TULLY
TUNSTALL
TUR(C)K
TURNBULL
TURNER
TURNEY
TURPIN
TUTHILL
TUTTLE
TWINING
TYLER
TYNDALL
TYRRELL
TYSON
UNDERWOOD
UPDIKE
UPHAM
UPSHAW
UPSHUR
UPTON
URQUHART
USHER
VAIL
VALE
VALENTINE
VANARSDALE
VANB(E)UREN
VANCAMP
VANCE
VANDERBILT
VAND(E)USEN
VANDEVENTER
VANDYCK
VANDYKE
VANHORN(E)
VANKAMPEN
VANLOON
VANMETER
VANNESS
VANNEST
VARNEY
VAUGH(A)N
VEAZEY
VEAZIE
VENABLE(S)
VERNON
VESEY
VICKERS
VICKERY
VINCENT
VINSON
VINTON
VIVIAN
VOS(E)
VOSS
VREELAND
WADDELL
WADDILL
WADE
WADSWORTH
WAG(E)NER
WAG(G)ONER
WAINWRIGHT
WAIT(E)
WAKEFIELD
WAKEMAN
WALBRIDGE
WALCOTT
WALDEN
WALDO
WALDRON
WALES
WALKER
WALL
WALLACE
WALLEN
WALLER
WALLIN(G)
WALLIS
WA(L)MSLEY
WALSH
WALTER(S)
WALTON
WARBURTON
WARD
WARDEN
WARE
WARFIELD
WARING
WARNER
WARREN
WARRICK
WARRINGTON
WARWICK
WASHBURN(E)
WASHINGTON
WATERHOUSE
WATERMAN
WATKINS
WATSON
WAT(T)ERS
WATT(S)
WAUGH
WAY
WAYNE
WEAVER
WEBB
WEB(B)ER
WEBSTER
WEEDEN
WEEDON
WEEK(E)S
WEEMS
WEIR
WEIS(S)(E)
WELBORN
WELCH
WELD
WELDEN
WELDIN
WELDON
WELLER
WELLINGTON
WELLMAN
WELLS
WELSH
WELTON
WENDEL(L)
WENTWORTH
WEST
WESTBROOK
WES(T)COTT
WESTERVELT
WES(T)LEY
WESTON
WETMORE
WHAL(L)EY
WHARTON
WHEAT
WHEATLEY
WHEATON
WHEDON
WHEELER
WHELDON
WHIPPLE
WHITCOMB
WHITE
WHIT(E)FORD
WHITEHEAD
WHIT(E)MAN
WHITESIDE
WHITEFIELD
WHITING
WHITLOCK
WHITMER
WHITNEY
WHIT(T)AKER
WHIT(T)(E)MORE
WHITTIER
WHITTINGTON
WHITTLE
WHITTLESEY
WICK(E)(S)
WICKHAM
WICKLIFFE
WIGGIN(S)
WIG(G)INTON
WIGHTMAN
WILBER
WILBUR
WILBURN
WILD(E)
WILDER
WILDMAN
WILK(E)S
WILKIE
WILKIN(S)
WILKINSON
WILLARD
WIL(L)COX
WILLETT(T)(S)
WIL(L)(E)Y
WILLIAMS
WILLIAMSON
WILLIS
WILLISTON
WILLITS
WILLOUGHBY
WILLS
WILMER
WILMOT
WILSON
WILTON
WINCHESTER
WIN(C)KLER
WINDHAM
WIN(D)SOR
WING
WIN(G)FIELD
WINN(E)
WINSHIP
WINSLOW
WINSTON
WINTER
WINTHROP
WISDOM
WISE
WISEMAN
WISWALL
WISWELL
WITHAM
WITHERS
WITHERSPOON
WITT
WITTER
WOLCOTT
WOLF(E)
WOLFF
WOODARD
WOODBRIDGE
WOODBURY
WOODCOCK
WOODFORD
WOODHOUSE
WOODHULL
WOODLEY
WOODMAN
WOODROW
WOODRUFF
WOOD(S)
WOODSON
WOODWARD
WOODWORTH
WOOL(D)RIDGE
WOOL(L)EY
WOOLSEY
WOOSTER
WOOTEN
WOOTTON
WORCESTER
WORDEN
WORKMAN
WORLEY
WORRALL
WORRELL
WORTH
WORTHINGTON
WORTHLEY
WRAY
WREN(N)
WRIGHT
WYATT
WYCKOFF
WYCLIFFE
WYLIE
WYMAN
WYNKOOP
WYNN(E)
YALE
YANC(E)Y
YARB(O)ROUGH
YARDLEY
YARNALL
YARNELL
YATES
Y(E)AGER
YEOMAN(S)
YOCUM
YORK(E)
YOUNG
YOUNGER
YOUNGLOVE
ZIMMERMAN(N)

THESE MANUSCRIPTS MAKE IDEAL GIFTS

ROOTS RESEARCH BUREAU, LTD., Dept. 1173
39 W. 32 Street, Suite 704
N.Y., N.Y. 10001

Please send me postpaid the manuscript (or manuscripts) indicated below. I enclose $30.00 ($50.00 for any two, $75.00 for three) as payment in full. (New York State residents, add N.Y.S. sales tax.) It is understood that I will receive a refund if I am not satisfied.

Your Name ______________________________

Street and No. ______________________________

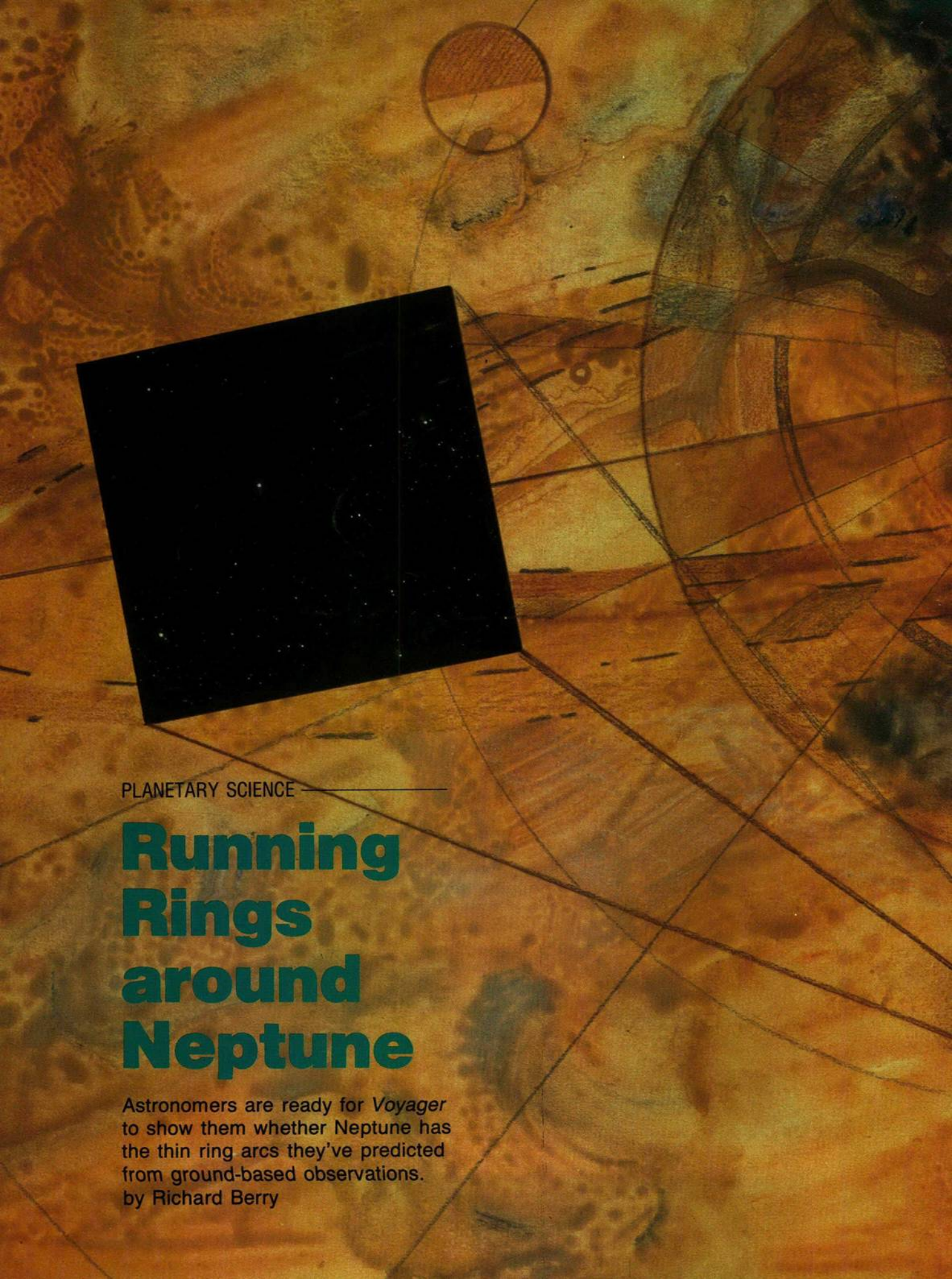
City ______________ State ________ Zip ________

Family Names of manuscripts desired

____

____

MEMBER BETTER BUSINESS BUREAU OF GREATER NEW YORK CUSTOMER COMMITMENT PROGRAM



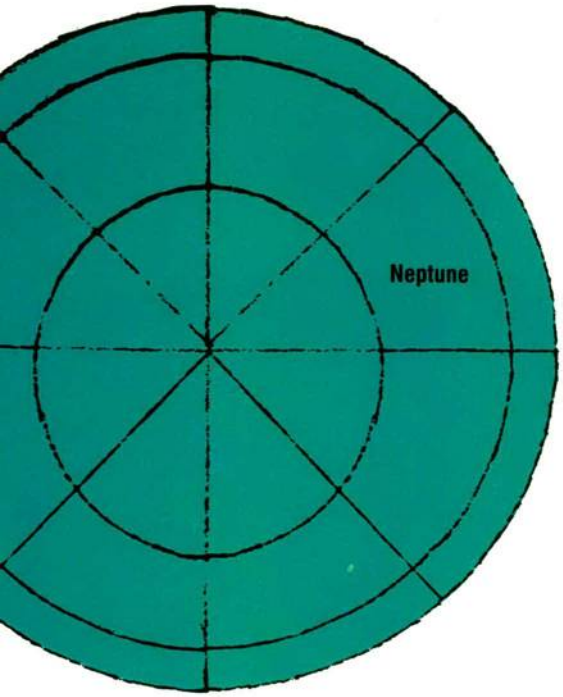
PLANETARY SCIENCE

Running Rings around Neptune

Astronomers are ready for *Voyager* to show them whether Neptune has the thin ring arcs they've predicted from ground-based observations.

by Richard Berry

SEARCHING FOR RING ARCS on approach to Neptune, *Voyager 2* will transmit hundreds of images to Earth.



Inner Ring Arc Radius

Middle Ring Arc Radius

Outer Ring Arc Radius

ARCS RATHER THAN RINGS characterize the Neptunian "ring" system. As few as one or as many as dozens of satellites may grip fine ring material in gravitational resonances.

Three days and five hours before flyby, *Voyager 2*'s cameras begin an extraordinary sequence of images. Over and over for thirteen hours the shutter will open, light will fall on the sensitive video tube, and *Voyager 2* will radio a picture to Earth. One after another, images of Neptune's ring system will brighten distant computer screens.

The cameras will have given planetary scientists their first-ever views of the Neptunian rings a mere three weeks before *Voyager*'s August 25 encounter with Neptune.

The rings will be thin — that much everyone agrees on — and will appear as short arcs of rings rather than as complete rings. How many arcs will *Voyager* see? No one knows. How will they be arranged? Unknown. What holds them in place? A mire of theory and speculation. In short, astronomers know almost nothing about Neptune's rings.

But it's *Voyager*'s job to find out.

Discovery by Occultation

Phil Nicholson has been observing Neptune's rings — or trying to — since 1981. "A few years after the Uranian rings were discovered," he said, "the question arose about whether we should start observing Neptune occultations to see if there were rings. We did the first one in Australia and did not see rings." Other occultation experiments also failed to detect any rings. Within a few years most astronomers had given up on finding Neptunian rings.

"A few people continued doing occultations because occultations are also used to probe the atmosphere of the planet," Nicholson said. "In 1984 two groups observed an occultation in Chile from two telescopes 100 kilometers apart, solid confirmation that something at Neptune had blocked starlight."

But they did not see a companion occultation on the other side of the planet, as they would have if Neptune had a complete ring. That led occultation teams to rethink their previous ideas and to speculate that Neptune's rings were unlike the continuous rings of Jupiter, Saturn, and Uranus, that Neptune had partial rings, or ring arcs.

Nicholson and other astronomers now observe Neptune occultations at a wavelength of 2.2 micrometers in the near infrared, a wavelength at which Neptune's methane atmosphere absorbs nearly all the light that strikes it. "Neptune is crossing the Milky Way right now," said Nicholson, "so there are lots of opportunities to observe occultations. About three per year have actually been observed."

But not every occultation yields a hit. Out of forty-some events observed to date, only in eight has the star's light been blocked. Even now Neptune's partial rings continue to bedevil Earth-bound observers. Of those eight occultations, Nicholson considers that only five are good data. But from this limited data comes all we really *know* about Neptune's rings.

"There are arcs at several different radii spanning a 20,000-kilometer range from the innermost radius to the outermost," said Nicholson. "From the statistics, about 10 percent of the 300,000-kilometer circumference of the arc orbits is actually occupied by ring arcs. That's 30,000 kilometers worth of ring arcs.

"We think a typical ring arc is no more than a few thousand kilometers in length, because in several instances an occultation has been seen at one observatory but not from an observatory a few thousand kilometers away," Nicholson said. "If the typical ring arc is 1,000 kilometers long, then there are thirty arcs, but that could be wrong by a factor of ten in either direction," he said.

According to Nicholson, "We're in the embarrassing position that if we make any prediction now, we're going to be proven resoundingly wrong by the spacecraft. But it's important to try to predict what's going to be at Neptune, because the *Voyager* spacecraft must examine specific places to search for the suspected ring arcs."

Theory Runs Arcs around Neptune

"There's always the chance," said Caltech ring theorist Peter Goldreich, "that you'll narrow your view in order to make some progress too early, and you'll leave out some essential feature. It's possible that we've gone completely in the wrong direction."

'Working Model' of Neptune's Ring Arcs

Name	Radius (km)	Uncertainty (±) (km)
Inner	42,000	2,000
Middle	57,000	2,500
Outer	67,000	4,000

Radial widths between 11 and 17 kilometers.
Arc lengths of a few thousand kilometers.
Reflectivity approximately 5 percent.

But Goldreich and other ring modelers have forged ahead anyway. "From the observations, we think Neptune has long-lived equatorial arclike structures at two to three planetary radii. We assume they're not just transient clouds of debris that last only a few years, because there are no complete rings observed."

The problem is that ring arcs must be confined if they are not to become rings. Because the arcs have some width, ring particles at the inner edge of an arc have shorter orbital periods than those at the outer edge of the arc, and the inner material will "lap" the outer material after a few thousand orbits, or a few years time.

"We assume that something confines the arcs," said Goldreich, "so we ask, 'could it be something we already know about, like Triton?' Our conclusion is, 'no, Triton can't do it.'" Neither can Neptune or Nereid.

"So, by elimination, we expect satellites in the general vicinity of the ring arcs. How many satellites? How big will they be? And the really big question: What's different about these hypothetical Neptunian satellites?"

The simplest case is that a single large satellite orbits with a circular orbit in the equatorial plane. But such a satellite can't do the job alone, Goldreich said. It needs one or more helpers, and each new ring requires another large satellite. "You get too many moons this way," he commented.

"So we took a different tack," explained Goldreich. "We said, 'maybe the satellite is in a disturbed orbit.' Well, tidal friction circularizes elliptical orbits quickly, so an orbit can't stay elliptical, but an inclined orbit can last the age of the solar system."

Goldreich and his colleagues Scott Tremaine and Nicole Borderies demonstrated theoretically that a satellite with an orbital inclination had many resonances capable of confining short arcs. Not only did such a satellite generate what theoreticians call corotation resonances that confine the arcs, but it also generated Lindblad resonances that pump energy into the arc particles, compensating for energy lost in collisions between them.

Such a satellite might be 300 kilometers in diameter and orbit some 70,000 kilometers out, in an orbit inclined 10 degrees from the equatorial plane of Neptune. "This picture remains a speculative sort of best guess," says Goldreich. "It will be fun to see if we've got it right."

Relentless Grinding

"If you look at what happens with rings," said University of Colorado planetary astronomer Larry Esposito, "you see rings as dynamic phenomena with short lifetimes. The Uranian rings, for example, have a maximum age of 100 million, maybe a billion years."

But rings continually renew themselves, Esposito said, from the breakup of large particles and moonlets embedded in them. "Initially the solar system was an immense mess," he said. "When the planets formed, there were all sorts of material all over the place. Stuff went very quickly from big moons to dust in the early days, with a bevy of moons and a bevy of rings around each of the planets."

Because all material in a ring system eventually ends up as dust, Esposito said, and because dust is dragged into the atmosphere or ejected from the system, rings decay and disappear.

"If rings only last 100 million years," said Esposito, "then you might ask, 'don't you need an awful lot of material to start with for us to still have any rings?' Well, it turns out this is not the way it works."

According to Esposito, most of the mass remains in the biggest objects. But we see the small particles, because small particles have more surface area for the same mass. Massive objects can easily last the age of the solar system, and as they break down, they supply fine particles that make up the visible rings.

"I predict a dozen intermediate-size moons, lots of small moons to hold the ring arcs in place, and at least half-a-dozen rings with bands of dust around them," says Esposito.

His prediction stems from the conviction that *Voyager* is not privileged to see Neptune at a special time in its 4.5 billion-year history. "It's crazy to think that we're going to fly *Voyager* by when a single large moon has found some recently created material to make ring arcs with," says Esposito. "It's physically too unlikely. The most likely configuration has lots of material in it, with an inefficient process of collisions creating the ring material we'll see."

Triton and Nereid

It's the presence of Triton, claimed Cornell University astronomer Joseph Burns, that distinguishes the Neptunian ring system from those of the other giant planets. "We expect satellites in the outer solar system to have evenly spaced, circular orbits located in the equatorial plane," he said. "But that's not the case with Triton.

"Triton is a huge moon in a retrograde, inclined orbit. The other Neptunian satellite, Nereid, has the most eccentric satellite orbit in the solar system. These bodies speak for a system that's evolved differently."

Triton's backward orbit is the joker. Triton could not have formed the way the large, regular satellites of the other giant planets did, out of a cooling nebular disk orbiting the planet. According to Burns, Triton was most likely captured when Neptune was still an enormous contracting ball of gases.

"In the early solar system there were lots of big objects floating around," Burns explained. "Triton ran backwards into the outer envelope of Neptune, slowed, and was captured in an orbit."

The gas giants probably captured lots of other objects the same way, but the orbits of those bodies evolved rapidly, so most of them got "eaten up" by the planet that captured them.

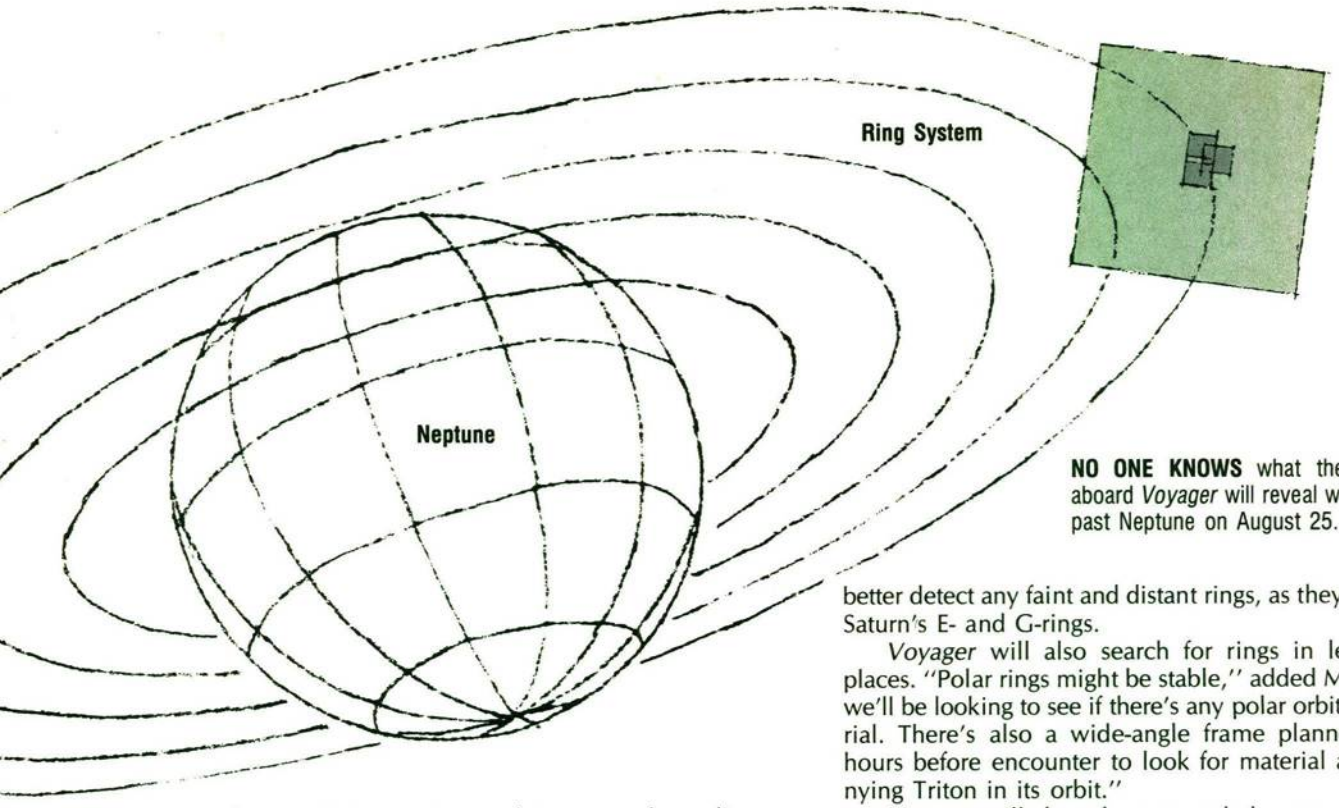
"This captured material today forms the rock-and-ice cores of the giant planets," said Burns. "The puzzles we want to solve are what caused Neptune's odd pair of satellites and precisely how is that connected to the planet's strange set of 'rings'."

Running the Rings

"Images," maintained Carolyn Porco of the Lunar and Planetary Laboratory and a member of the *Voyager* imaging team, "are going to provide us with most of the interesting information on Neptune's ring system."

On the inbound leg of the flyby, the first task of the *Voyager* cameras is to locate ring material and small satellites as early as possible. Satellites as small as 100 kilometers across may be found six weeks before encounter.

"We start our regular ring and satellite search sequences when we're 27 days from encounter," said Ellis Miner, assistant project scientist for *Voyager* at the Jet Propulsion Laboratory. "We expect to see the largest ring arcs about three weeks before closest approach,"



NO ONE KNOWS what the cameras aboard *Voyager* will reveal when it flies past Neptune on August 25.

said scientist Porco, "or maybe sooner, depending on how much light they reflect."

As the cameras carry out their search, the spacecraft teams have their jobs cut out for them. With the aid of blemish maps and computer-generated star charts, the imaging team will locate new objects and then pass the job of determining their orbits to the navigation team. From predicted positions the mission sequence team will prepare camera aiming instructions for *Voyager*.

"Four days before encounter we'll be able to figure out where new objects will be. We observed Puck [1985U1] at Uranus that way. We have three retargetable frames inbound — that's all we could get — so we can look at three separate objects at most with these retargetables. We have one retargetable frame after Neptune encounter. These four frames are very important," Porco said. The highest-resolution retargetable frames could have an image scale of 1.5 kilometers per pixel — as good as the best frames taken at Uranus.

Three days out from Neptune, *Voyager* steps up its search for ring arcs with a 110-frame, thirteen-hour "ring movie" to catch ring material as it revolves through the camera's field of view. "At the time of the ring-arc movie," Miner explained, "the narrow-angle frame covers not quite the full ansa [tip] of the rings. Neptune is out of the frame so we can make longer exposures."

"When we get close, there isn't enough time for another movie," Porco said, "so we'll shoot ring mosaics. We examine what parts of the ring system have not yet been covered in an image series, and then we place the next picture there." Ring mosaics search the ring region in a fraction of the time a ring movie does. "The demands on camera time are intense," says Porco, "outrageously intense."

During the near-encounter phase, near the time of flyby, *Voyager* continues its exploration of the ring system. "We're taking three high-phase-angle ['look-back'] pictures to look for dust and fine particles," said Porco, "and near ring-plane crossing we'll take three more exposures that look across the whole ring system." By imaging the rings nearly edge-on, the cameras can better detect any faint and distant rings, as they did with Saturn's E- and G-rings.

Voyager will also search for rings in less likely places. "Polar rings might be stable," added Miner, "so we'll be looking to see if there's any polar orbiting material. There's also a wide-angle frame planned seven hours before encounter to look for material accompanying Triton in its orbit."

Voyager will also take extremely long exposures to search for tenuous ring material. "Our motivation for long exposures is our regret that we didn't take deep exposures at Uranus," said Porco. "Possibly the most informative picture we got at Uranus was one 96-second exposure look-back frame that showed the ring plane almost completely filled with fine dust."

"The idea is to go as deep as possible. We mean to go as faint, as black, as optically thin as we can." Porco stressed, "We don't want to be fooled again."

What the Arcs Will Say

Voyager will totally revolutionize the study of Neptune's ring system. Between the deep searches, ring movies and mosaics, and the high resolution retargetable frames, astronomers will see both the grand design and the fine detail of a system they've never seen before.

"The Uranian rings were pretty well characterized by occultations before we got to Uranus," observer Nicholson commented, "but at Neptune we are not in that situation. We have incomplete observations and we have a very poor understanding of what's there. A lot of us are just waiting for the pictures to come in, not knowing much more than anybody else."

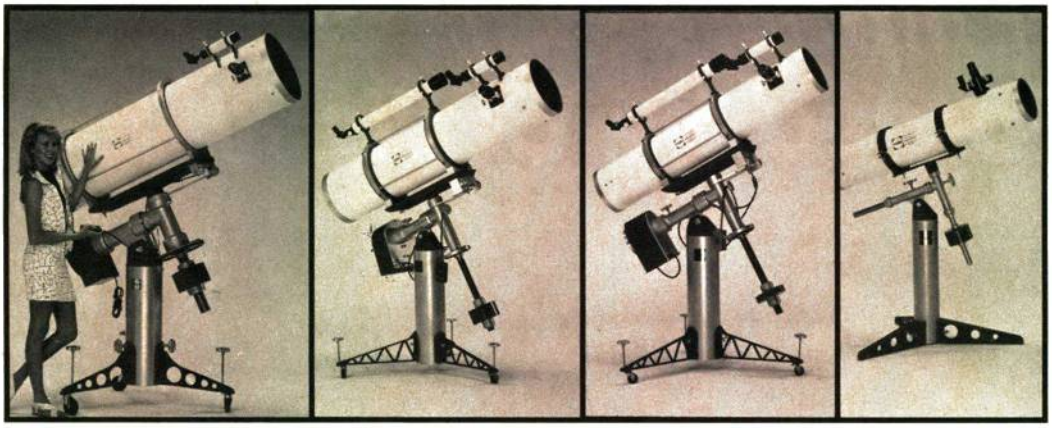
"If we find that the Neptune ring system is empty," stressed Esposito, "it's telling us something different than if we find it's full of all sorts of objects. Objects that are clearly youthful say something quite different than a few immense moons guarding a few small ring features that could have been maintained for the age of the solar system."

Voyager might thus distinguish between possible histories of the Neptune system and, by implication, distinguish between scenarios for the formation of the outer planets.

"It's more fun to do predictive science than it is to explain things — rationalize things — after they've been observed," says Goldreich. "We have very little to go on at Neptune, so we stretch a lot. But at a well-defined date in the future — at the flyby — we'll find out whether we've understood the system. The fun is to see how well we can do." □

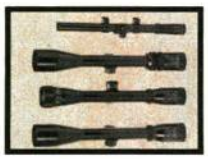
PARKS TELESCOPES & COMPONENTS

WORLD CLASS, QUALITY PRODUCTS SINCE 1954

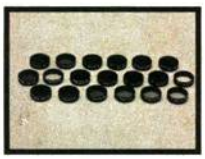


PARKS OFFERS THE FINEST RESEARCH QUALITY, FULL FEATURED NEWTONIANS AVAILABLE.

PARKS EQUAT. REFRACTORS



PARKS RIFLESCOPES



PARKS FILTERS

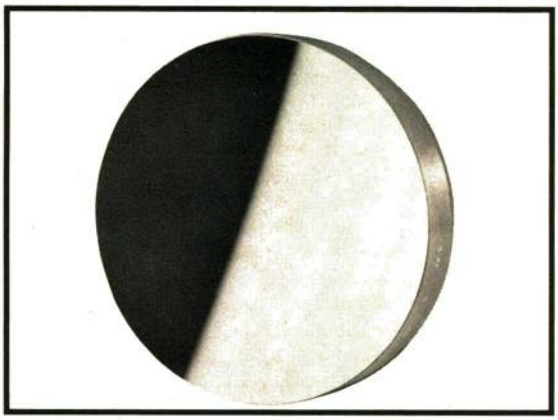
PARKS SPOTTERS

PARKS BINOCULARS

PARKS CASSEGRAIN

PARKS COMPONENTS

PARKS OPTICS... Unsurpassed Quality!



You won't see any false or exaggerated claims in this ad. Simply the facts.

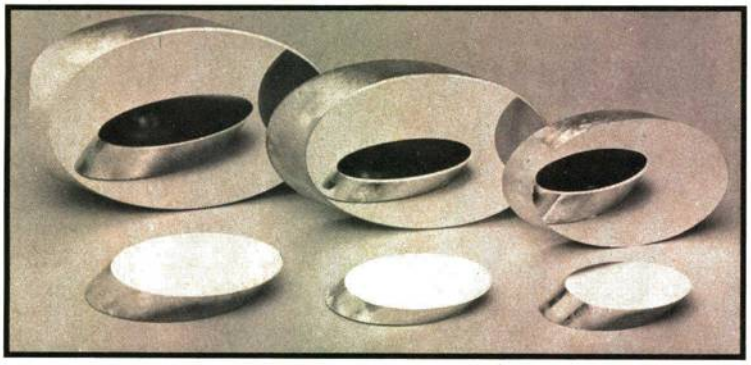
At Parks, we are committed to supplying you with the finest quality optics at the most affordable prices. How do we accomplish this without sacrificing the precise optical quality necessary for a first class telescope mirror? Simple. Over the last several years we have been upgrading and enlarging our in-house optical fabrication department and refining existing industrial methods, materials and techniques. The result is two fold: top quality telescope mirrors (the very same used in our complete Newtonian series), and affordable prices.

All Parks mirrors are manufactured from fine annealed, low expansion, pyrex glass and are free from surface and material defects.

Each and every Parks mirror passes a series of critical tests, including the sensitive, double pass auto-collimation test with a Ronchi ruling at focus, and the Focault test at the center of curvature.

Each mirror is guaranteed to meet or surpass the industry standard Rayleigh limit of optical precision. All Parks optics are diffraction limited.

These mirrors are not mass produced, but are hand figured, serialized, and certified by our master opticians.



Diameter (Full Thickness 1:6)	Factory Direct Price	Ellipticals	Factory Direct Price
6″ f/6	149.00	1.33″	30.00
6″ f/8	149.00	1.55″	35.00
8″ f/3.5	299.00	1.83″	40.00
8″ f/6	199.00	2.14″	45.00
10″ f/3.5	599.00	2.60″	55.00
10″ f/5	399.00	3.10″	85.00
12½″ f/5	599.00	3.50″	225.00
16″ f/5	2,195.00	4.00″	259.00
2″ Thick		5.00″	359.00
16″ f/5	1,185.00		
18″ f/5	1,595.00		
20″ f/5	1,995.00		
24″ f/5	Call		

Complete optical tube assemblies available

Complete line of quality telescopes, binoculars, riflescopes, telescope making components, equatorial mounts, and accessories.

PARKS OPTICAL

270 Easy St., Simi Valley, CA 93065
Information ..... (805) 522-6722
Order only in CA 1-800-43-PARKS
Order only National 1-800-44-PARKS

All Parks products come with a 100% satisfaction guarantee or return in original condition for a full refund, less shipping within 30 days of receipt. Add 3% in continental USA to cover shipping and handling. (Minimum $4). Air freight and worldwide shipping information upon request. FREE COLOR CATALOG. (foreign USD $5). Parks Optical is not open to the public. Merchandise available through mail order or at any authorized Parks dealer worldwide.

Elliptical Galaxies Forged by Collision

The collision and merging of spiral galaxies may give birth to elliptical galaxies.
by Karen Hartley

Armed with a surfeit of gas and dust, two spiral galaxies square off in space. For billions of years they have been on a collision course, and at last the moment of impact is at hand.

As they approach each other, their tenuous outer boundaries intermingle. Besides the visible matter they bring to the fray, each galaxy harbors vast amounts of dark matter in a halo surrounding its disk. The friction caused by the interaction of the dark-matter haloes slows the advance of the galaxies. Gravity now fuels the encounter, inexorably drawing each galaxy into the other. Once the merger is complete, a single, fused nucleus remains, flanked by two tails of stars stretching in opposite directions.

Some astronomers believe that such mergers of disk galaxies result in the formation of galaxies without disks — elliptical galaxies. These giant spheroidal star systems are poor in star-forming gas and young stars and, other than displaying varying degrees of flattening, have little structure of which to speak. This once controversial scenario has gained strong support in the last few years from new observational evidence and more detailed computer modeling.

Astronomers have long wondered why nature saw fit to arrange stars into two main structures in galaxies: disks and spheres. One camp theorizes that both components were determined a few hundred million years after the Big Bang and are, in essence, incapable of evolving from one type of galaxy to another. This view holds that spheroids formed rapidly from free-falling protogalactic gas clouds, which imparted random motions to the stars. The disks, on the other hand, formed from gas clouds that had already collapsed into rotating disks.

Other astronomers, however, believe that galaxy formation did not occur that quickly. In fact, they propose that galaxies are constantly forming and, more specifically, that ellipticals are the products of mergers between spiral galaxies.

Francois Schweizer of the Carnegie Institution of Washington would place himself in the second group. Galaxy mergers are still occurring and producing new, bigger galaxies sometimes shaped quite differently than the progenitor galaxies, he contends. Although many astronomers would concede that some ellipticals are the products of mergers, Schweizer said the debate centers on whether a *majority* of them formed that way.

To support his argument, Schweizer points to NGC 7252, a galaxy he has studied and one that exhibits properties typical of those now being discovered in ellipticals. Three interesting features emerge. The first is that the galaxy has two long tails but only one nucleus, which strongly suggests the recent merger between two disk galaxies of roughly the same mass. By dividing the lengths of the tails by their velocities, astronomers estimate that the two galaxies began to form their tails about 1 billion years ago.

The second characteristic concerns the way light is distributed across the galaxy. The light distribution in NGC 7252 is similar to that of an elliptical galaxy rather than a disk system, which suggests that the two disk systems have fully merged and "relaxed," or stabilized, to form a true elliptical galaxy.

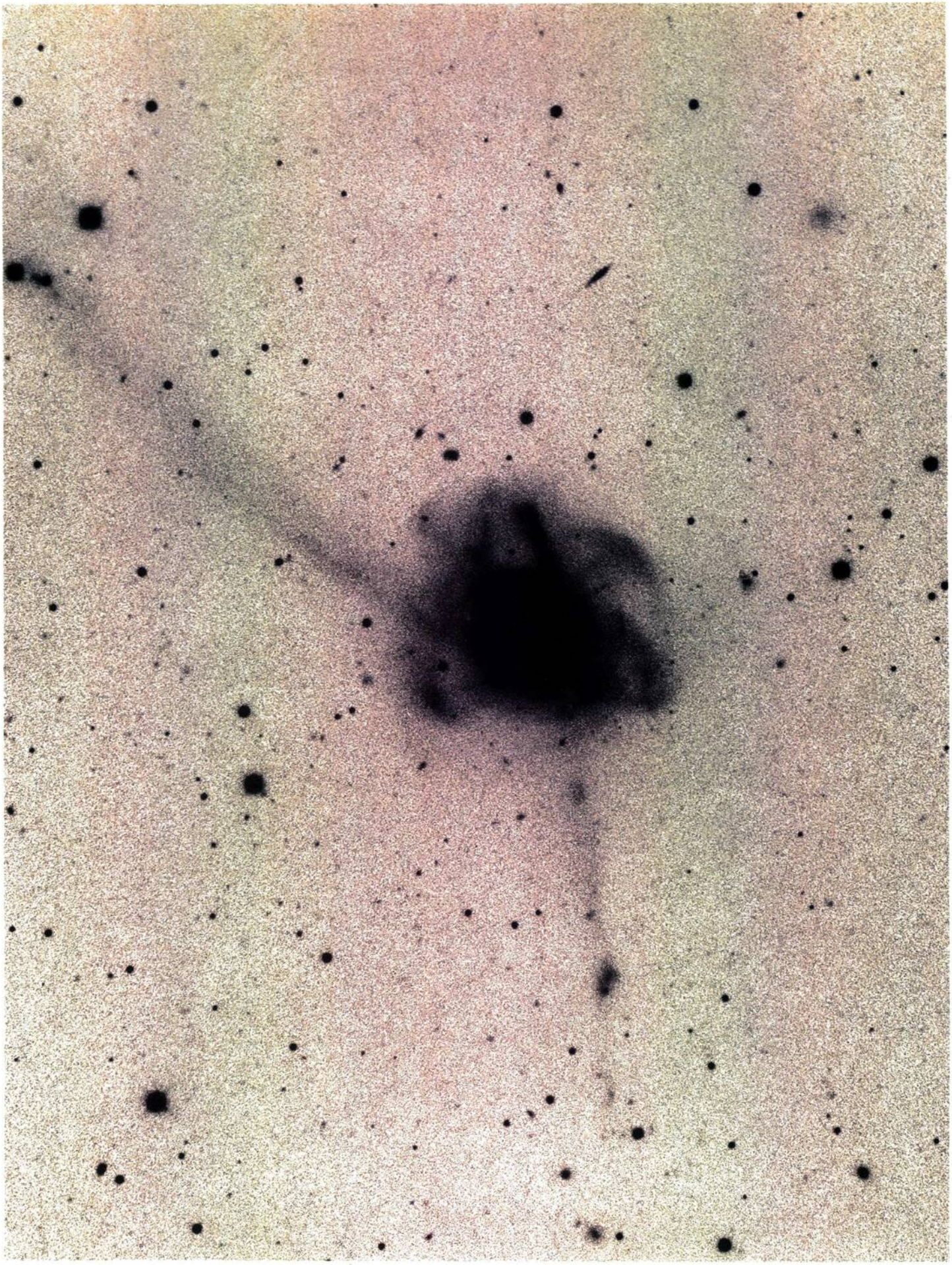
But the real clincher for a merger in NGC 7252, Schweizer said, is the existence of a two-motion system within the body of the galaxy, something four independent research groups recently observed in other ellipticals. Measurement of the velocity of NGC 7252's ionized gas clearly shows that a gas disk immediately surrounding the galaxy's nucleus rotates in one direction between 50 and 60 miles per second, while the gas immediately beyond rotates in the opposite direction at about 30 miles per second. In an extreme case, Schweizer said, the whole core of an elliptical galaxy may not only rotate relatively fast and in the opposite direction from the outer body but at some arbitrary angle to it.

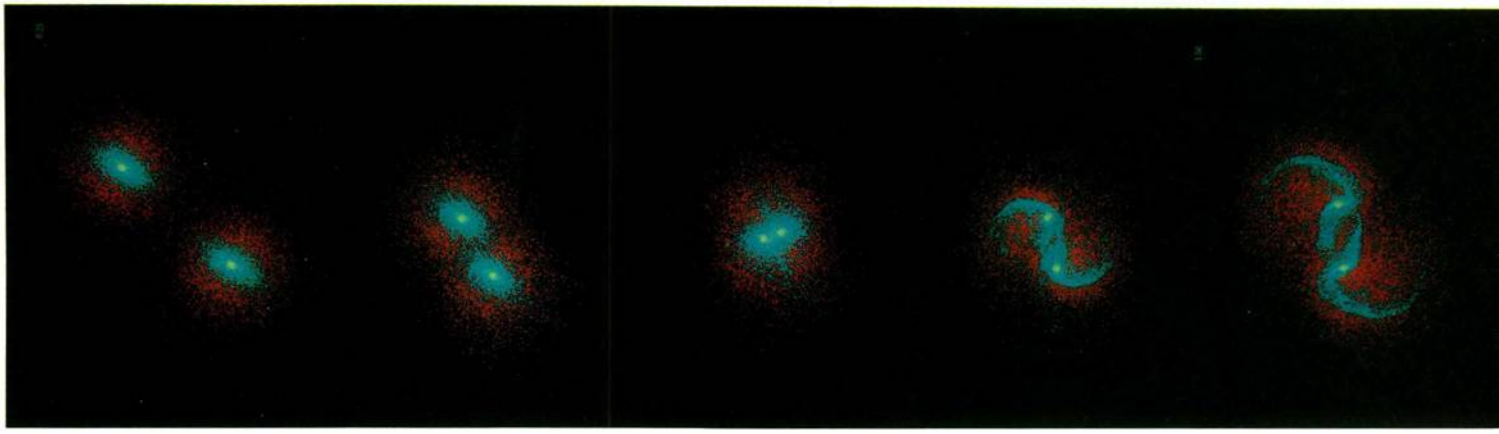
Schweizer cites additional evidence to support his claims. A recent computer simulation of two colliding galaxies reproduced NGC 7252's crossed tails and counter-rotations. Other observations have revealed the existence of molecular gas within the galaxy, which indicates that even 1 billion years after a collision star formation may still be taking place. Finally, Schweizer notes the presence of sharp-edged shells, or ripples, found in NGC 7252 as well as in other elliptical galaxies. They are thought to be either the stretched-out remains of a galaxy that has wrapped itself around another during a merger or gas "stolen" during a near collision.

Despite these observations, opponents of the merger theory question why the centers of elliptical galaxies are a hundred to a thousand times denser than the disks of the spiral galaxies from which they merged. Mass and energy conservation arguments have suggested that mergers would lower rather than raise the degree of central condensation.

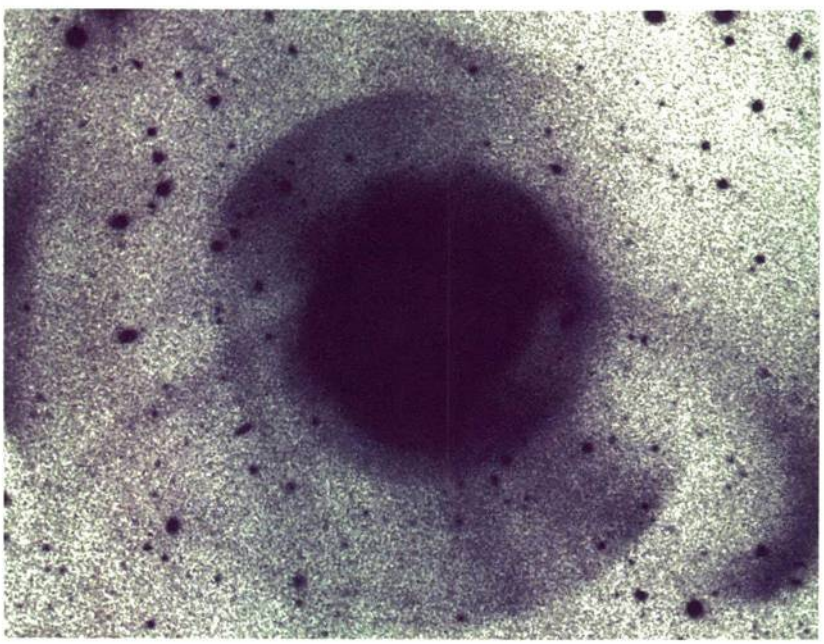
The key issue here, Schweizer said, is what happens to the gas when two galaxies merge. Recent observations show that the molecular gas in merging galaxies virtually collapses into the center of the galaxies. "You can have absolutely tremendous amounts of

TWO LONG TIDAL TAILS and chaotic gas in NGC 7252 indicate a merger of two galaxies, but only one body remains. The distribution of the stars in this object resembles that of an elliptical galaxy.

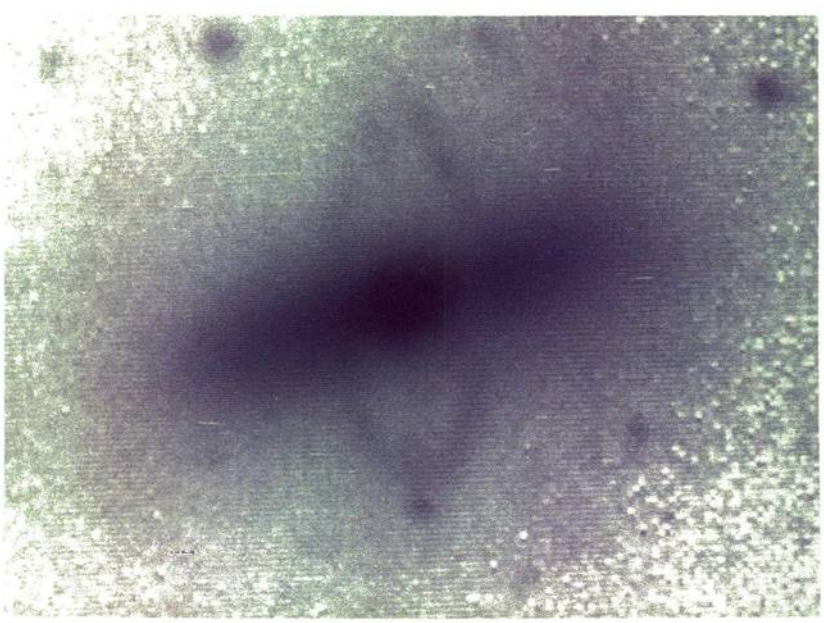




A NEW COMPUTER MODEL that takes into account the gravitational effects of the dark-matter content of merging galaxies (red) shows that significant braking occurs as the two objects interact. The bulge components (yellow) merge into a single nucleus and the disk material (blue) is flung off in opposite directions. Before their merger the galaxies are in bound, cometlike orbits.



TENUOUS RIPPLES OF MATTER ring NGC 474, a disk-shaped galaxy. Astronomers believe the ripples consist of material robbed from the outer disk of a neighboring galaxy during a close encounter.

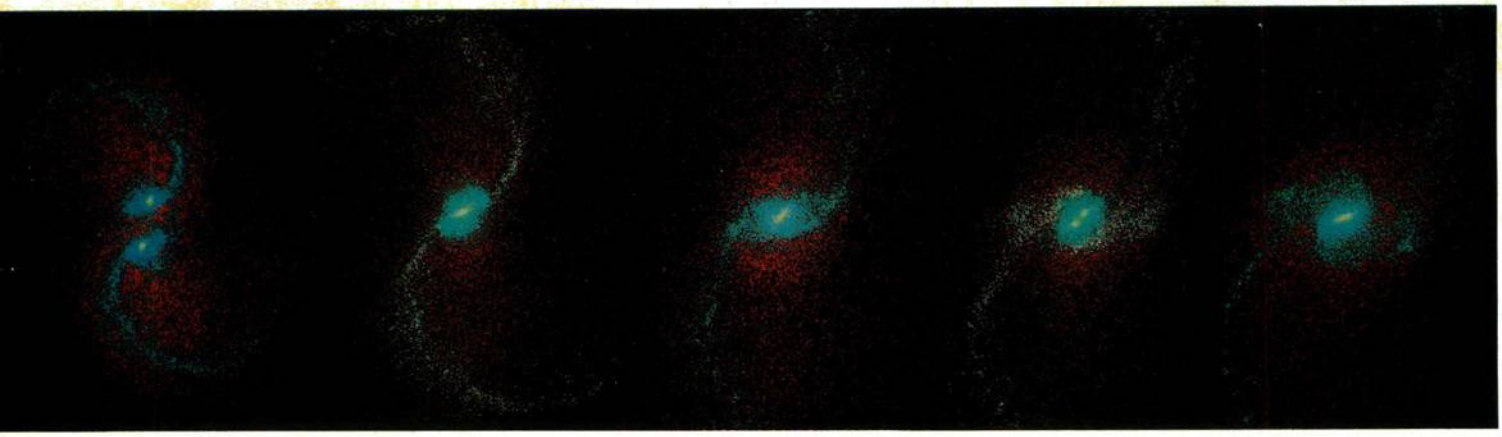


THE DIFFUSE HALO AND RING surrounding the galaxy ESO 415-G26 may be remnants of the galaxy's merger with a smaller, gas-rich companion.

gas, like 10 billion solar masses, sitting near the center of this colliding system," Schweizer said. "When the gaseous contents of two galaxies collide, the crunching of the gas leads to some spectacular fireworks: that gas turns into stars. By the time the fireworks are gone and the dust settles, you have a much, much brighter core of an elliptical galaxy."

Although this remains only a theory, Schweizer said that *Infrared Astronomical Satellite* (*IRAS*) observations have revealed this gas. For example, bright infrared galaxies such as Arp 220 and NGC 6240, both optically faint objects, are experiencing strong central bursts of star formation. The ultraviolet and visible luminosity from the starburst activity is absorbed by great quantities of dust surrounding these galaxies. The dust, however, is warmed to between 30 and 300 kelvins and emits infrared photons, which were detected by *IRAS*. Subsequent deeper optical images revealed distortions or tidal tails in Arp 220 that suggest a possible merger.

"The star-formation rates inferred from the infrared luminosity are on the order of 10 to 100 solar masses a year, or ten to one hundredfold the typical rate of quiescent spiral galaxies," Schweizer said. At these rates the gas contents of normal spiral galaxies would likely be depleted between 10 million and 100 million years. Other astronomers argue, however, that this infrared luminosity could merely be caused by active galactic nuclei or the conversion of kinetic energy into ultraviolet radiation from collisions between gas clouds in a dust-



embedded environment.

There are additional observations that also seem to indicate that ellipticals could not have formed rapidly in the early universe. William Baum of Lowell Observatory measured the surface brightness distribution of three galaxies located in the Coma Cluster. Baum used a charge-coupled device and three color filters: one sensitive specifically to the spectral absorption band of magnesium and two others flanking that absorption band. Baum and his colleagues chose magnesium because, as a heavy metal produced from the explosions of other stars, it represents a way to tell the age of stars. "It's a way of doing archaeo-astronomy," said John Gallagher of Lowell Observatory. "It's like going to the Grand Canyon and looking at the deepest sediment layers and asking what things were like."

Normally an elliptical galaxy shows a high abundance of magnesium in its center, where most star formation has occurred, and a decreasing abundance in its outer regions, where less star formation took place. Baum's surprising finding was that magnesium richness extends throughout elliptical galaxies, even into the faint outskirts. What that means, Gallagher said, is that in ellipticals the stars in the outer regions were born in a place where there was time to convert most of the gas into stars and to repeat that process several times.

Supporting the merger observations are detailed computer models that simulate the kind of interactions seen in nature. Tidal interactions between galaxies were first simulated in 1972, when Juri and Alar Toomre presented computer simulations that demonstrated how "bridges" and "tails" could result from the head-on collision of two disk galaxies. The Toomres' idealized models — which had the mass and gravitational forces of each galaxy concentrated at the center of hundreds of massless test particles — suggested that elliptical galaxies could result if the approach velocity of the two galaxies was slow enough to allow them to interact.

Recent work by Joshua Barnes of the Institute for Advanced Study in Princeton, New Jersey, shows the first numerical models of interacting galaxies in which bulges, disks, and massive haloes are modeled as three-dimensional systems, each with thousands of particles. "Although we've known for a while what happens with head-on collisions, Barnes' work shows for the first time what happens when galaxies miss a bit," said Alar Toomre of the Massachusetts Institute of Technology.

In his work Barnes simulates two disk galaxies of the same mass in bound, parabolic orbits. (Astronomers consider the chance hyperbolic passage of two galaxies much too rare an occurrence.) Explaining the simulation, Barnes said, "as the galaxies pass each other, they exert a strong gravitational pull. The gravity yanks the middle of the galaxy out from underneath the edge of the disk so the stuff on the edges goes flying off in more or less a straight line."

The dark matter factored into the computer model contains most of the mass of the system and exerts a tremendous gravitational pull, according to Barnes. That pull slows down the visible parts of the galaxy and retards the motion. "So instead of escaping out to infinity, as would happen if two galaxies had formed as individual objects, the luminous parts of the galaxy are trapped," Barnes said. The simulation closely resembles the real life elliptical NGC 2623, as well as NGC 7252.

Barnes ran contrasting models with and without the dark-matter haloes and found that dark matter does indeed exert an influence on the behavior of merging galaxies. Barnes concluded that galaxies can merge on a short timescale — his simulation depicted a 1 billion-year period. In addition, Barnes noted, the friction between the massive haloes of the two galaxies is enough to provide the braking necessary to slow the galaxies' initial approach and allow them to merge before the tails fly away.

Despite observational and theoretical support for their theories, the scientists who believe that most, if not all ellipticals are the result of mergers have a ways to go before the majority of astronomers embrace the idea. The issue is further complicated by the problem of when these mergers supposedly took place. If mergers occurred during the first billion years of the universe, by which time all galaxies should have formed, does that mean that mergers were a process of early galaxy formation only? Schweizer doesn't think so. He estimates that three quarters of ellipticals formed from disk galaxies during the first half of the age of the universe — when all galaxies were closer together — and one quarter formed in the latter half.

Another issue is the role of mass transfer during close encounters: How big a part is played by the transfer of matter from one galaxy to another in a near-encounter or collision and exactly what effects does it have? Some astronomers speculate that polar ring galaxies — those with a ring of gas and stars orbiting the poles of a disk galaxy, like a ring around a cigar — might be formed as one galaxy draws matter from another. This "siphoned" matter could pass over the poles and result in two disks rotating at right angles to each other.

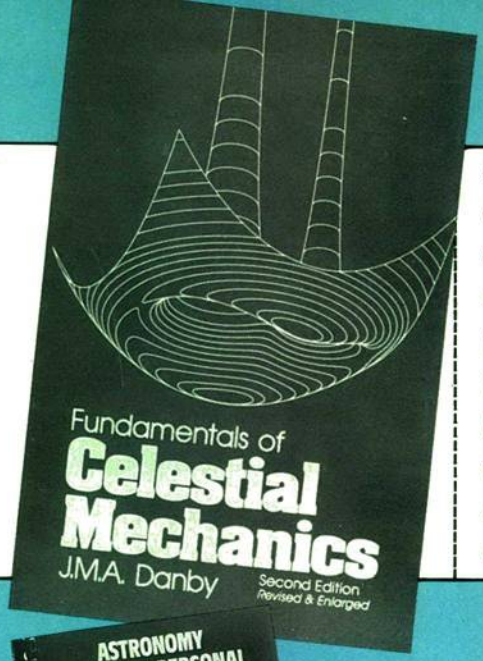
Despite the questions that remain, the evidence seems to be mounting that elliptical galaxies are the products of merged disk galaxies. Although they resemble homogenized systems of sedate, old stars, this may belie their history as once-great star-makers. Said Schweizer: "To me it is quite interesting that ellipticals were once thought to be very simple — not to say, perhaps, even slightly boring — objects. Yet now they are turning out to be delightfully complex." □

Karen Hartley is a science writer who lives in Boston. Her most recent article, "A New Window on Star Birth," appeared in the March 1989 issue.

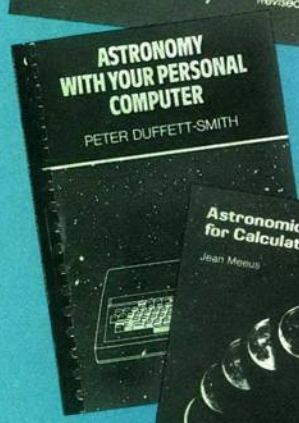
Fundamentals of Celestial Mechanics, by J.M.A. Danby. This up-to-date and practical application text introduces conventional mechanics of celestial objects in 14 no-nonsense chapters on central orbits, properties of solid bodies, determination of orbits, numerical procedures, the motion of the moon, and more. Ideally suited both to beginning students who are concerned with general applications of dynamics to astronomy, and to educated astronomers who want to learn the fundamental, practical details of orbital work. Includes complete appendixes. 465 pages, #30182, **$19.95.**

NEW!

ASTRONOMY SOFTWARE

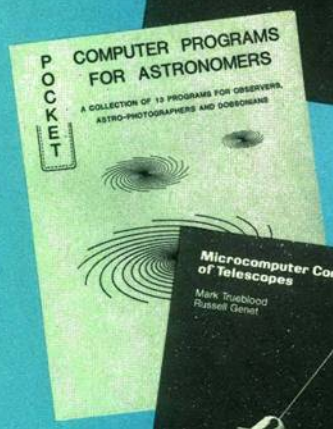


Astronomy With Your Personal Computer, by Peter Duffett-Smith. Contains 26 BASIC subroutines for calculating positions of planets, times of moonrise and moonset, circumstances of lunar and solar eclipses, positions of comets, and much more. Includes advice on how to apply subroutines to solve particular requirements. 256 pages, paperback, #30130, **$18.50.**



Astronomical Formulae for Calculators, 3rd edition, by Jean Meeus. For the more mathematically advanced, provides formulae for you to write programs to determine the positions of the jovian moons, the principal perturbations affecting the planets — and lots more. Fully worked-out examples. 201 pages, paperback, #30054, **$15.50.**

Pocket Computer Programs For Astronomers, by Fred Klein. Contains 13 Pocket Computer BASIC programs for calculating altitudes and azimuths, jovian satellite positions, age and phases of the Moon, comet positions, and much more. Besides the programs, it also tells you how the programs work so you can customize them for machines other than the Pocket Computer. 100 pages, paperback, #30055, **$12.95.**



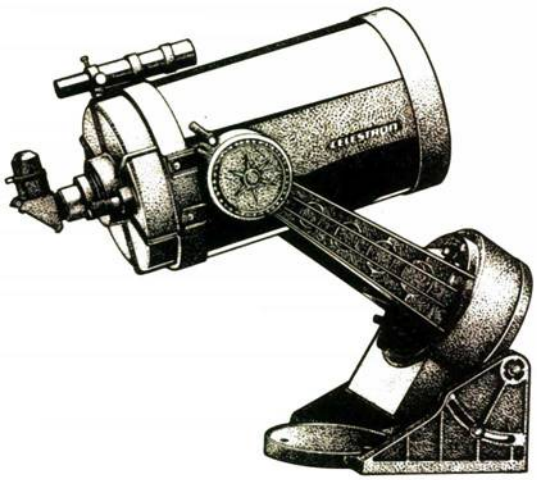
Microcomputer Control of Telescopes, by Mark Trueblood and Russell Genet. This definitive volume describes both the theory and practice of operating a small- or medium-size telescope under full computer control. Covers control theory, motors, position sensing devices, the motions of the sky, control electronics and more. 300+ pages, paperback, #30065, **$19.95.**

Planetary Programs and Tables from -4000 to +2800, by Pierre Bretagnon and Jean-Louis Simon. Re-create history's night skies and compute future positions of the Sun and planets. This book includes formulae, tables, and microcomputer programs in FORTRAN and BASIC to compute the longitude of the Sun, and the geocentric longitudes and latitudes of Mercury, Venus, Mars, Jupiter, Saturn, Uranus, and Neptune in the past, present, and future. 160 pages, paperback, #30135, **$19.95.**

STARS.BAS/STARS.DAT, diskette by ASTRONOMY. Your personal computer can become a desktop planetarium with the help of this program and data file. Designed for the IBM-PC and its compatibles with CGA graphics, this diskette will allow you to easily, and quickly, plot star maps on a computer screen. This software was described in "How to Plot Star Maps on Your Computer," ASTRONOMY, August 1985. A free copy of this issue will be included with each diskette, #18027, **$29.95**

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233. Include for postage and handling: U.S. $1.50; Canada and foreign add 15% (minimum $3.00). Wisconsin residents add 5% sales tax.

TUTHILL, YOUR ASTRONOMICAL FRIEND, OFFERS THESE FINE ASTRONOMICAL PRODUCTS...



CLASSIC 8

Now we can adapt the famous CELESTRON ULTIMA 8 CORDLESS Electronic Drive System with its internal rechargeable batteries to fit completely inside the base of the CLASSIC Celestron 8 Telescope.

As a bonus this rechargeable Cordless Electronic System doubles as a Deluxe Quartz-Locked Drive Corrector when you are ready to try Astrophotography. In addition it gives you total freedom from messy, cumbersome external power supplies so that field operation is hassle-free.

ACCURATE POLAR AXIS FINDERS

The Tuthill Precision Polar Axis Finder saves you many hours of valuable viewing time. Place Polaris (or Sigma Octans) on the cross-hairs of the offset optical gunsight and your scope will automatically be aligned precisely on the pole. No special skill required, ideal for beginners, no guessing, no tripod leveling, no precious viewing time wasted. Makes astro-photography easier by reducing adjustments needed. Finding things will be a pleasure. Fits all SCT scopes. Patent #4,260,253.

Specify: Deluxe NH $178 / Deluxe SH $198

ANNOUNCING THE TUTHILL SUPER CHALLENGE:

We invite you to purchase any Tuthill Solar Skreen®, Luna Shade®, Heated No Du Cap®, Celestial Navigator Mark V® Digital Circle, Precision Polar Axis Finder, Isostatic Equatorial Mount®, Permanent Pier Head, Plossl Eyepiece, 80mm Finder, or Star Trap® Power Module Drive Corrector and any so-called competitive product. You test ours and theirs on the same object, using the same scope, on the same day or night and if the Tuthill product is not superior we will take it back for a full refund, no questions asked — AND YOU MAY NOT EVEN HAVE TO RETURN IT!!

TUTHILL, THE TRUSTED NAME IN TELESCOPES AND UNIQUE ACCESSORIES.

FREE VIDEO TAPES with each SCT scope we sell. (Value $80) Send a large, self-addressed, stamped envelope (8" x 12", 65¢ postage) for our information kit including our NEW 35-page catalog, "Tuthill's Twenty-Two Telescope Tips and Maintenance Instructions."
Video tapes now available in PAL format.

*Time payment plan available
*We repair scopes
*We export scopes to both Hemispheres
*We take MC, VISA, COD, & personal checks AND DO NOT WAIT FOR THEM TO CLEAR

FREE DEMONSTRATIONS

Roger W. Tuthill, Inc.
11 Tanglewood Lane, Box 1086A
Mountainside, NJ 07092

Call 800-223-1063
in NJ 201-232-1786

Meade & Celestron
LUMICON Carries a full line of telescopes & accessories. Fast Delivery competitive prices. Both Catalogues $3.

LUMICON FOR HIGH PERFORMANCE

ASTROPHOTO OF THE MONTH

The "Flame Nebula" NGC 2024 in Orion. Also known as the "Christmas Tree" or the "Tank Trucks" nebula. NGC 2024 is seen best usually with either a LUMICON DEEP-SKY or UHC filter. Photo by Don N. Reiners, 16" f/5, 40 min. using hypered 2415 film and a LUMICON 2" EASY-GUIDER.

20mm NAGLER

Also new 12mm & 16mm NAGLERS
TELE VUE™ EYEPIECES USE THE BEST!!

ALL IN STOCK

Renaissance 4" f/5.5. Telescope	**$1395**
7.4, 10.4, 13, 17, 21, 26mm Plossl, 50°	**$89**
1.8X or 2.5X Tele Vue Barlow Lens	**$89**
32mm Plossl, widest true field in 1¼"	**$109**
55mm 2" Plossl, widest possible field	**$190**
15mm Wide-Field, 1¼" eyepiece, 65°	**$129**
19mm Wide-Field, 1¼" eyepiece, 85°	**$139**
24mm Wide-Field, "superb," 65°	**$159**
32mm Wide-Field, 2" eyepiece, 65°	**$229**
40mm Wide-Field, "awesome," 65°	**$289**
4.8mm Nagler, 82° field	**$149**
7mm Nagler, 1¼" eyepiece, 82° field	**$185**
9mm Nagler, 82° field, "the best"	**$219**
11mm Nagler, 82° field, 1¼" or 2"	**$235**
13mm Nagler, 82° field, 1¼" or 2"	**$249**
12mm Nagler, type II, 82°, 1¼"/2"	**$249**
16mm Nagler, Type II, 82°, 1¼"/2"	**$299**
20mm Nagler, Type II, 82°, 2" only	**$340**

NEW! ENHANCED SILVER DIAGONAL MIRRORS BOOST TELESCOPE PERFORMANCE

LUMICON 1.3" & 2.1" enhanced silver diagonal mirrors & 1¼" star diagonal.
The new LUMICON diagonal mirrors have a special enhanced silver coating with a protective overcoating for long life. Visible reflectivity is 98-99% compared to 86-89% for standard aluminum coated mirrors. The extra 10-12% transmission is like adding an inch of aperture! The substrate is fine annealed Pyrex flat to 1/8 wave.

1.32" **$29.95** 1.52" **$34.50** 1.83" **$39.50**
2.14" **$49.50** 2.60" **$65.00** 3.10" **$89.50**
4.25" **$149.50**

ENHANCED SILVER STAR DIAGONAL

90° star diagonals with above enhanced silver mirrors in a CNC machined black anodized aluminum body. Performance far exceeds prism diagonals.
1¼" (1.32" mirror) **$89.50**
2" (1.83" mirror)(see photo above) .. **$145.00**

LUMICON FILTERS STOP LIGHT POLLUTION

UHC Filter™

ULTRA HIGH CONTRAST

The **LUMICON UHC FILTER** is specially designed for visual astronomy in areas of severe light pollution or for viewing very faint nebulae at any location. **UHC** stands for **U**ltra **H**igh **C**ontrast and this filter is guaranteed to yield a higher visual contrast on planetary and emission nebulae than any other filter at any price. 24nm visible bandpass, 482-506nm. Transmission=90-97%.

"I CAN SEE THE OWL NEBULA!"
Tom Kramer saw the Owl Nebula, M-97, for the first time using a LUMICON UHC Filter. He stated, *"I had never seen M-97. . . I attached the UHC Filter and tried again. M-97 was right there. I could not believe it! The UHC Filter should be standard equipment."* **Tom Kramer, Sayville, NY**

For optimum astronomy, use either the **LUMICON DEEP-SKY Filter** or the **LUMICON UHC Filter**

DEEP-SKY FILTER™

The **LUMICON DEEP-SKY FILTER** improves your view of **all** deep-sky objects including galaxies and comets. It removes natural and man-made light pollution and yields 3-6x contrast gain for nebulae and 1-3x contrast gain for clusters and galaxies. It is ideal for **both** visual use and B&W or color photography. This gentle filter yields the most natural view of any LPR filter available today. 90nm visible bandpass. 442-532nm. H-Alpha 656nm transmission = 85-95%. Visible transmission = 85-95%.

	Standard	Premium*
0.96" LUMICON DEEP-SKY Filter threads into most 0.96" eyepieces		**$59.50**
1¼" LUMICON DEEP-SKY Filter threads into most 1¼" eyepieces	**$59.50**	**$79.50**
48mm LUMICON DEEP-SKY Filter (1.75" aperture), threads into most 2" eyepieces. Also fits LUMICON EASY-GUIDERS	**$99.50**	**$119.50**
2" LUMICON DEEP-SKY Filter (1.5" aperture), threads into most 2" eyepieces. Also has male & female camera T-threads for prime focus photography	**$99.50**	**$119.50**
72mm LUMICON Giant DEEP-SKY Filter (62, 67, 77mm adapter, $8)		**$299.50**
1¼" LUMICON UHC Filter threads into most 1¼" eyepieces		**$99.50**
48mm LUMICON UHC Filter (1.75" aperture) fits most 2" eyepieces		**$199.50**
Set of Both premium **DEEP-SKY** and **UHC Filters** (Save 11%), Premium		**$159.50**
LUMICON H-BETA Line Filter (9mm bandpass at 486nm). For the California Nebula, Horsehead Nebula, and other extremely faint nebulae. **1¼"**	**$99.50, 48mm**	**$199.50**
Oxygen-III Filter for very faint planetary and diffuse nebulae, 11nm bandpass at 496nm and 501nm O-III lines **1¼"**	**$99.50, 48mm**	**$199.50**
Telephoto lens adapter for 2" or 48mm filter. Select 46, 49, 52, 55, 58mm		**$6.95**
Universal adapter for 1¼" filters. Adapts the 1¼" filters to any 1¼" eyepiece		**$16.00**
Universal adapter for 48mm or 2" filters. Allows use of any 1¼" eyepiece		**$20.00**

**Premium filters are selected best of the lot and typically have 5-10% higher transmission. Not always available. Include individually measured transmission data.*

ADJUSTABLE PIGGYBACK MOUNT

The LUMICON adjustable piggyback mount is ideal for telescopes of 6-16" aperture. It permits **both** vertical and sideways adjustment for optical alignment. Also ideal to mount LUMICON 80mm SUPER-FINDER™, large telephoto lenses and small telescopes up to about 5 lbs. **LUMICON Adjust. Piggyback Mount .. $45**
Specify telescope size: 6", 8", 10", 11", 14", 16"

H-ALPHA PASS FILTER

Yields spectacular contrast gains in B&W photograph with telephoto lenses. Yields pin-point star images. Superb with hypered 2415. For color, use the Minus Violet (MV) Filter.

Specify Lens Size	H-Alpha	(MV)
46, 48, 49mm	**$39.00**	**$34.00**
52, 55, 58, 62mm	**$49.00**	**$39.00**
67, 72, 77mm	**$59.00**	**$49.00**
82mm	**$69.00**	**N/A**
Hypered 2415 film, 36 *exp*	**$10.95**	**$3/$29**

DEEP-SKY ASTROPHOTOGRAPHY

SR-V 3200 NEW FILM

FILM HYPERSENSITIZATION KITS†

LUMICON HYPER-KITS™ yield 3-15X film speed gain in long exposures. They are safe & simple to use. Easy HYPER-KIT includes a chamber with all controls and fittings, thermometer, a refillable cylinder of non-flammable forming gas & hand-operated vacuum pump.
U.S. Patent 4,473,636

MAKE YOUR OWN HYPERED FILM

MODEL 300 HYPER-KIT sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds **$295.00**

MODEL 600 HYPER-KIT [See Photo] Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates **$350.00**

MODEL 1200 HYPER-KIT is for 4X5" plates and film up to 5X7" Has 2 gas cylinders and includes temperature controller .. **$595.00**

Temperature controller for any HYPER-KIT **$59.50**

Electric Vacuum Pump, Model R-10 **$280.00**

GUIDE OFF-AXIS FOR LOVELY ASTROPHOTOS

All **LUMICON EASY-GUIDER™** off-axis guiders† have both radial and 360° rotational adjustments for 5X easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms for bright guide-stars.
Specify Camera and Telescope type.
U.S. Patent #4,448,500

NEWTONIAN EASY-GUIDER™

Full aperature. Installs in secs. Specify 2" or 1¼".
NEWTONIAN EASY-GUIDER **$169.50**
3X Relay Diagonal (see photo) **$79.50**
Illuminated reticle eyepiece system .. **$89.50**
Guider for Hasselblad **$350,** Mamiya 645 **$199**

CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Dynamax-8. Includes 50mm achromatic lens for f/5.8 operation-3X shorter exposures! **Superb rich field viewing, too!**
CASSEGRAIN EASY-GUIDER **$225.00**
Adapter for Hasselblad **$185,** Mamiya 645 **$159**

GIANT EASY-GUIDER™

For Celestron-11, C-14, and the 10" Meade 2120. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. **Also yields unmatched Rich-Field viewing.**
GIANT EASY-GUIDER **$395.00**
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE $20) ..... **add $99.95**
Adapter for Hasselblad **$195,** Mamiya 645 **$96**

WHAT DO YOU NEED?

1. Illuminated reticle eyepiece **$89.50**
Lumicon 12mm eyepiece system has adjustable L.E.D. illumination, dual crosslines, battery pack.
2. Cable release for long exposures .. **$9.95**

3. **LUMICON Quartz Drive Corrector $219**
Dual-axis drive corrector is essential for astrophotography and/or field use of your telescope. 40Hz/80Hz variable output controls telescope drive. 60Hz Quartz reference ±12VDC Declination control output. Both 110VAC and 12VDC input for home or field use. Declination reverse switch for Newtonians.
Declination motor (state telescope) .. $70
NEW Deluxe Digital Qtz. Drive Correc. **$298**

NEW **SRV3200**

HYPERSENSITIZED FILM

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.).

Film Type, 35mm	Exposures	Price
2415, Ultra-fine B&W, red sens.	36	**$10.95**
SRV3200, fastest of all, color neg	24	**$13.95**
Konica SR3200, unhypered	24	**$8.50**
Konica SR400, fine grain color neg	12	**$10.95**
3M 1000, fastest slide film	12	**$12.95**
Fujichrome RD100, fine grain slide	24	**$12.95**
D-19 B&W Developer	1 gal.	**$6.95**

LUMICON®

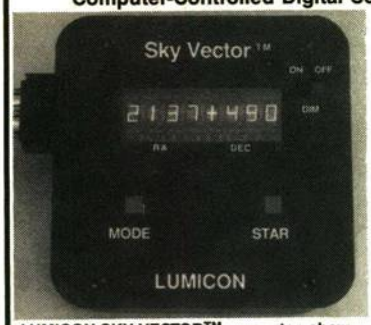
2111 Research Dr. #5A, Livermore, CA 94550
For phone orders please call (415) 447-9570
LUMICON Products catalogue $2.
Foreign orders add 6% ($8 minimum)
California Residents add 6% tax.
Prices subject to change w/o notice
Hrs. M-F 9am - 5pm; Sat 11am - 3pm

LUMICON means INNOVATION

LUMICON, 2111 Research Dr., #5
Livermore, CA 94550 (415) 447-9570

LUMICON® SKY VECTOR™- *NEW!*

Computer-Controlled Digital Setting Circles, only $498



LUMICON SKY VECTOR™ computer, showing digital readout of coordinates, and easy-to-use controls. Shaft encoders are included (not shown). The coordinates are for Minkowski 1-79, a 13th mag. planetary nebula.

The LUMICON SKY VECTOR™ is a computer-controlled digital setting circle system. It represents a break-through in both computer performance and low price. To find an object just move the telescope until the coordinates of the SKY VECTOR™ match those of the object desired.

Each LUMICON SKY VECTOR™ includes one computer with digital readout, two precision digital shaft encoders, connecting cables, & mounting hardware (for most popular telescopes). **Specify telescope.**

Incredibly Smart! thus Incredibly Easy!

- Digital right ascension readout to 1 minute of R.A.
- Digital decl. readout to 10 arc-min
- Digital altitude readout to 1°
- Motor drive ***not required!***
- Polar alignment ***not required!***
- Just sight two stars!

The computer's sophisticated program (over 3000 lines of code) determines **everything** from an initial sighting of just two stars!

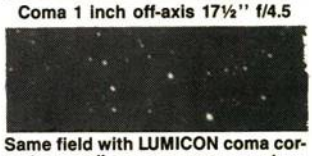
- **No need** to enter latitude, longitude, sidereal time, date, etc.
- Works **equally well** for alt-azimuth telescopes like Coulter Odyssey and equatorial mounts like C-8, Meade 2080. The computer automatically knows the difference.
- Uses Epoch 2000.0, 1975.0 or 1950.0 coordinates.
- Light weight, only 2 oz. permits mounting near the eyepiece, if desired. Only 2.6"x2.6"x1".
- 9V Battery lasts many nights.

LUMICON SKY VECTOR™ for Meade 2080,2120,C-8,C-11, *(Specify)* **$498**
For Celestron-14 .. **$525.** For any alt-azimuth (Dobsonian) telescope .. **$498**
For Coulter Odyssey 8", 10", 13", 17½" *(Specify telescope)* **$498**
SKY VECTOR KIT. You must supply adapting hardware. For skilled ATM's only **$449**

Reference catalogues listing coordinates of 1000's of objects
Burnham's *Celestial Handbook,* Vol. I, II, III (Epoch 1950.0) **$36.85**
The *Revised New General Catalogue* (all NGC and IC, Epoch 1975.0) . **$35.00**
Sky Catalogue 2000.0, Vol. II, doubles, variables, deep-sky objects ... **$29.95**

COMA CORRECTOR

Coma 1 inch off-axis 17½" f/4.5



Same field with LUMICON coma corrector; smaller, more numerous stars.

This computer-designed LUMICON 2" lens reduces coma and flattens the field for both viewing and photography. It threads into LUMICON 2" EASY-GUIDERS for effortless installation. This lens is optimized for f/4.5 and reduces aberrations for f/3.5 to f/5 Newtonians. Off-axis images are much smaller, making off-axis guiding far easier and yielding round pinpoint star images in photos. Since star images are sharp over a full 2¼" circle, you can use medium format cameras in addition to 35mm cameras. This zero power lens does not change image scale nor shift focus, and all lens surfaces are multi-coated for highest efficiency. Although designed for photography you may also use this lens to improve image quality in wide-field viewing with low power eyepieces.

LUMICON Coma Corrector/Field Flattener Lens **$285.00**
LUMICON 2" EASY-GUIDER **$169.50**
2" EASY-GUIDER (Mamiya 645) **$199.50**
Adapter for Hasselblad **$185.00**
Adapter for Bronica SQ-A .. **$175.00**
2" Extension for viewing ... **$26.00**

1.5x, 1.8x MULTIPLIER LENS

1.8x Multiplier Lens

The computer-designed LUMICON 2" Multiplier/Field Flattener multiplies the image scale in photography by 1.8x (f/4.5 becomes f/8). Use it with any LUMICON 2" EASY-GUIDER. It multiplies by 1.5x without the included extension tube. This lens is optimized for f/4.5, but will work well with any optical system. It may also be used visually as a highly corrected 2" Barlow lens.
LUMICON 1.5x/1.8x multiplier lens **$195.00**

NEW! LOW PROFILE HELICAL FOCUSERS

FROM $49.50

LUMICON® LOW PROFILE FOCUSERS
LUMICON now offers 3 different low-profile helical focusers. They stand only 1¼-1½" above the telescope tube. Use the 1¼" or 2" versions for viewing. Use the 2" non-rotating focuser for convenient photography with the LUMICON 2" EASY-GUIDER™.

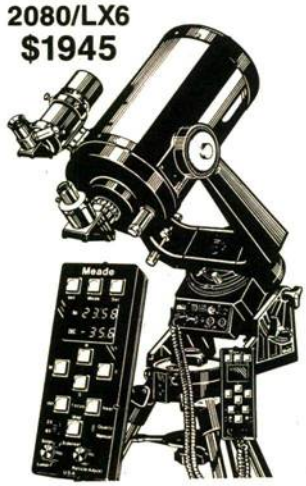
Select your desired base-plate shape!
Flat, 7" OD, 9½" OD, 12½" OD, 16" OD, 21" OD, SUPER-FINDER base plate.
LUMICON 1¼" Helical Focuser **$49.50**
LUMICON 2" Helical Focuser **$59.50**
LUMICON Non-rotating Helical Focuser $79.50
2" rack & pinion low profile focuser .. **$139.00**
3 handles (see photo) for non-rotat. focuser **$12.95**
2"/1¼" adapter w/48mm filter threads **$20.00**
2" LUMICON EASY-GUIDER **$169.50**

MEADE® TELESCOPES

LUMICON, 2111 Research Dr., #5
Livermore, CA 94550 (415) 447-9570

2080/LX6 8" f/6 .. **$1945**
2120/LX6 10" f/6 . **$2495**
Digital readout system for 2080/2120/LX6 ..... **add $475**
8200 object memory CAT computer ..... **add $1195**

NEW 2080/LX6 $1945



Meade Model 2080/LX6: The most advanced Schmidt-Cassegrain telescope available today. The hand-held electronic command center controls all telescope functions, and has digital coordinate readout available as an option. The f/6.3 optics yield 2½x shorter exposures in astrophotography.

MEADE SCHMIDT-CASSEGRAIN TELESCOPES

MTS-SC8, 8" f/10 w/drive, MCOG **$998**
MTS-SC8 w/LX3 drive, MCOG **$1198**
2080/LX3, 8" f/10 w/MCOG .. **$1389**
2080/LX5, 8" f/10 w/MCOG .. **$1589**
2120/LX5, 10" f/10 w/MCOG . **$1995**
2120/LX3, 10" f/10 w/MCOG . **$1799**
2045/LX3 4" f/10 w/LX3 drive . **$795**
#39 declination motor for LX5 . **$109**
#38 (LX3) or #38A (2045) dec. mtr. **$99**
Dew shield - essential! 8" **$65;** 10" **$98**
LUMICON EASY-GUIDER for 2080 .. **$225**
EASY-GUIDER (f/4-f/10) for 2120 **$395**
CAT command control, 8200 objects **$1195**

MEADE SCHMIDT-NEWTONIAN TELESCOPES

MTS-SN6, 6" f/5, #788 drive .. **$649**
MTS-SN6 w/drive, MCOG **$698**
MTS-SN8, 8" f/4 w/drive, MCOG **$795**
MTS-SN8, 8" f/4 w/LX3 drive, MCOG **$1048**
#36 LX3 hand cntrl. & #38 dec. motor **$189**

MEADE NEWTONIAN TELESCOPES

Model 826C 8" f/6 w/motor, 2" focuser **$975**
Model DS-10A, 10" f/4.5 w/mtr., 2" focus. **$975**
Model DS-16A, 16" f/4.5 w/motor, 2" focuser **$1975**
Model DS-16A w/Sealmaster ball bearings for photography **$2195**
8X50mm finderscope w/brackets for DS-10,-16 ..... **$109**

LUMICON ACCESSORIES

48mm COLORED GLASS FILTERS

These 48mm Filters thread into LUMICON EASY-GUIDERS and most 2" eyepieces. Use adapter for 1¼" eyepieces. AR Coated.

Filter:	Bandpass	Trans	Price
Ultraviolet	320-420nm	85%	$35
Minus Violet	420nm-IR	96%	$29
Blue Tricolor	340-470nm	80%	$35
Hi Perf. Blue	300-540nm	95%	$35
Yellow	480nm-IR	98%	$18
Green	490-590nm	60%	$18
Orange	560nm-IR	98%	$18
Red	600nm-IR	98%	$18
H-Alpha Pass	640nm-IR	95%	$35
Cyan	340-580nm	95%	$59

Adapter for 1¼" eyepieces **$20**
Set of all 10 48mm filters ($340 list) **$298**

EYEPIECE PROJECTION

These adapters allow high magnification photography of the Moon and Planets using eyepiece projection. They may be used without any eyepiece for prime-focus photography. All adapters use standard camera T-rings.

Tele-Extender for Meade or Celestron SCT. **$32**
1¼" Basic Camera adapter, 2 part system **$32**
0.96" Basic Camera adapter, 2 part system **$32**
1¼" prime Focus adapter, fits 1¼" focuser **$22**
0.96" prime Focus adapter, fits 0.96" focuser **$22**
Camera T-ring, specify 35mm camera type **$12**

LUMICON 50mm, 80mm SUPER-FINDER™

Visual Astronomers prefer the LUMICON 80mm SUPER-FINDER™, since hundreds of deep-sky objects, including most Messier objects, are visible directly. SUPER-FINDERS also make nice small portable telescopes. 80mm aperture, F=300mm coated achromat. The deluxe SUPER-FINDER uses an 80mm, F=500mm air spaced achromat.

1¼" 50mm Finderscope **$59.50**, right-angle **$89.50**
1¼" straight-thru 80mm SUPER-FINDER ... **$169**
1¼" right-angle version, w/star diagonal **$195**
2" right-angle version, non-rotating focuser .. **$199**
1¼" Deluxe right-angle Super-Finder* **$279**
2" Deluxe right-angle Super-Finder* **$309**
25mm Cross-hair 1¼" eyepiece (12X) **$29**
*1¼" Star Diag. **$32**, 2" Star Diag., silver, **$145**
1¼" Amici Prism diag. for correct left-right views **$69.50**

2" ADAPTERS MEADE, CELESTRON TELESCOPES

These adapters convert refractors and Schmidt-Cassegrain telescopes for 2" operation. They allow use of 2" accessories, such as the LUMICON 2" EASY-GUIDER for photography. They also allow use of 2" eyepieces and/or 2" star diagonal for viewing.

2" adapter for C-8, Meade 2080, etc. . . . **$26.00**
2" adapter for Criterion 4000, 8000 ... **$26.00**
2" adapter for C-80, C-90, C-100 ..... **$39.50**
2" adapter for C-70, C-80F, C-90F, C-100F **$39.50**
2" Accessory adapter for Comet Catcher*, C-6*, Meade 310, 320 refractor **$30.00**
2" adapter for Takahashi E-130, 160 .. **$59.50**

ASTRONOMY

1989 Directory of Observatories, Planetariums, and Museums

Visit a professional observatory, explore the stars under the dome of a planetarium, wonder at the craftsmanship of antique telescopes — a world of astronomy awaits you at over 250 observatories, planetariums, and museums across the United States and Canada.

ALABAMA

Birmingham — Robert R. Meyer Planetarium. Birmingham Southern College, 35254. (205) 226-4770. Exhibits, lectures, planetarium shows, special children's programs. Open Monday-Friday and Sunday.

Florence — University of North Alabama Planetarium/Observatory. 35632. David Curott, (205) 760-4284.

Huntsville — Marshall Space Flight Center, 35812. Public Relations, (205) 544-0034.

ALASKA

Fairbanks — Geophysical Institute. University of Alaska-Fairbanks, Elvey Building, 99775. Public Relations, (907) 474-7598.

ARIZONA

Amado — Multiple Mirror Telescope Observatory and Fred Lawrence Whipple Observatory. P.O. Box 97, 85645. Dan Brocious, (602) 398-2432. Tours. By reservation only.

Flagstaff — Barringer Meteor Crater. Forty miles east of Flagstaff. Meteor Crater Enterprises, 121 East Birch, 86001. (602) 774-8350.

Flagstaff — Lowell Observatory. 1400 West Mars Hill Road, 86001. Paul Roques, (602) 774-2096. Exhibits, historical astronomical instruments, tours, lectures, public observing, open houses. Open Monday-Saturday.

Flagstaff — Northern Arizona University Campus Observatory. Department of Physics and Astronomy, Box 6010, 86011. Andrew P. Odell, (602) 523-2661. Public observing, open houses. Open Thursday evenings.

Tucson — Flandrau Planetarium. University of Arizona, Corner of Cherry and University Boulevard, 85721. Raymond Shubinski, (602) 621-4515. Exhibits, historical astronomical instruments, space artifacts, public observing, films, planetarium shows, laser shows, observatory, special children's programs. Open Tuesday-Sunday.

Tucson — Kitt Peak National Observatory. 950 North Cherry Avenue, 85719. Don Karl, (602) 620-5350. Exhibits, tours, lectures, films. Open Monday-Sunday.

Tucson — Steward Observatory. University of Arizona, 85721. (602) 621-2288.

ARKANSAS

Little Rock — University of Arkansas at Little Rock Planetarium. Natural Sciences Building, 2801 South University, 72204. Paul Engle, (501) 569-3259. Public observing, planetarium shows. Open Wednesday, Friday, and Sunday by reservation only.

CALIFORNIA

Apple Valley — Apple Valley Science and Technology Center. 22974 Bear Valley Road, 92308. Tony Heinzman, (619) 247-7267. Exhibits, classes, public observing. Open six days a week.

Berkeley — Lawrence Hall of Science. University of California, 94720. Barbara Ando, (415) 642-5133. Exhibits, historical astronomical instruments, space artifacts, classes, public observing, films, planetarium shows, special children's programs. Open Monday-Sunday.

Big Bear — Stony Ridge Observatory. P.O. Box 874, 92314. Tony Heinzman, (714) 585-5486. Open houses.

Edwards — Hugh L. Dryden Flight Research Facility, 93523. (805) 258-3446.

Fresno — The Discovery Center. 1944 North Winery Avenue, 93703. Jeanne Larson, (209) 251-5533.

Los Angeles — Griffith Observatory. 2800 East Observatory Road, 90027. (213) 664-1191. Exhibits, tours, public observing, planetarium shows, laser shows, special children's programs. Open Monday-Sunday.

Los Angeles — University of California-Los Angeles. Department of Astronomy, 405 Hilgard Avenue, 90024-1562. Marietta Stevens, (213) 825-4434. Public observing, planetarium shows, open houses. Closed summers. Open Monday-Friday by reservation during the school year.

Mount Hamilton — Lick Observatory. P.O. Box 85, 95140. Pat Shand, (408) 274-5062. Exhibits, historical astronomical instruments, tours, lectures, public observing. Open Monday-Sunday.

Palomar Mountain — Palomar Observatory. 92060.

Pasadena — Jet Propulsion Lab. 4800 Oak Grove, 91109. (818) 354-7006.

Pleasant Hill — Diablo Valley College. 321 Golf Club Road, 94523. Robert Searls, (415) 685-1230. Classes, planetarium shows, observatory, open houses. Open Monday-Friday.

Redding — Schreder Planetarium. 1644 Magnolia Avenue, 96001. Kenneth Adams, (916) 244-4600. Planetarium shows. Open Friday evenings.

Rohnert Park — Sonoma State University. Department of Physics and Astronomy, 94928. Gordon Spear, (707) 664-2267. Public observing, observatory. Open monthly.

Sacramento — Sacramento Science Center. 3615 Auburn Boulevard, 95821. Chris Holtz, (916) 449-8255. Exhibits, lectures, classes, public observing, films, planetarium shows, special children's programs. Open Monday-Sunday.

San Diego — Mount Laguna Observatory. Department of Astronomy, San Diego State University, 92182. (619) 594-6182.

San Diego — Reuben H. Fleet Space Theater and Science Center. 1875 El Prado, Balboa Park, 92101. Mary Hettinger, (619) 238-1233. Exhibits, space artifacts, lectures, classes, public observing, films, planetarium shows, laser shows, OMNIMAX theater, special children's programs. Open Monday-Sunday.

San Francisco — Exploratorium. 3601 Lyon Street, 94123. Linda Dachman, (415) 563-7337. Exhibits, historical astronomical instruments, films, laser shows. Open Wednesday-Sunday.

San Francisco — Morrison Planetarium. California Academy of Sciences, Golden Gate Park, 94118. Elizabeth Keough, (415) 750-7141. Exhibits, planetarium shows, laser shows. Open Monday-Sunday.

Santa Barbara — Gladwin Planetarium/Palmer Observatory. Santa Barbara Museum of Natural History, 2559 Puerta del Sol Road, 93105. Kay Woolsey, (805) 682-4711. Classes, public observing, planetarium shows, special children's programs. Open Monday-Sunday. (Planetarium open Saturday and Sunday.)

Santa Monica — Santa Monica City College Planetarium. 1900 Pico Boulevard, 90405. Jonathon Hodge, (213) 452-9223. Exhibits, lectures, classes, public observing, planetarium shows, observatory, special children's programs. Open Friday evenings.

Santa Rosa — Santa Rosa Junior College Planetarium. 1501 Mendocino Avenue, 95401. Ron Oriti, (707) 527-4640. Exhibits, lectures, classes, public observing, films, planetarium shows, open houses, special children's programs. Closed summers.

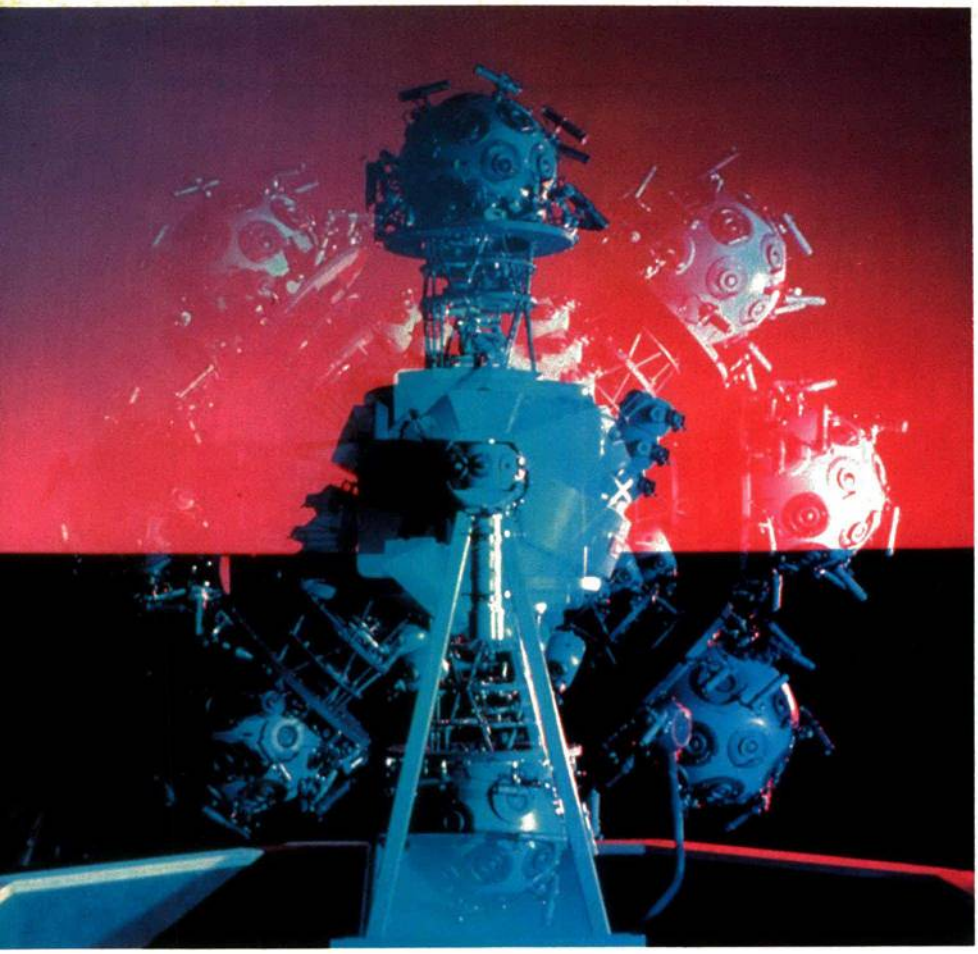
COLORADO

Boulder — Fiske Planetarium and Science Center. University of Colorado, 80309-0408. Gene Ammarell, (303) 492-5001. Exhibits, tours, lectures, classes, public observing, planetarium shows, laser shows, observatory, special children's programs. Open Monday-Friday.

Colorado Springs — Black Forest Observatory. 12815 Porcupine Lane, 80908. Paul B. Van Slyke, (719) 495-3828. Exhibits, tours, lectures, classes, public observing, films, open houses, special children's programs. By reservation only.

Colorado Springs — U.S. Air Force Academy Planetarium. 5O ATS/DOP, USAF Academy, 80840. Mickey Schmidt, (719) 472-2779. Planetarium shows. Open Tuesday-Sunday.

Denver — Chamberlin Observatory. 2900 East Warren Avenue, 80013. (303) 871-3222. Histor-



ical astronomical instruments, lectures, public observing. Open Tuesday and Thursday evenings by reservation.

Denver — Gates Planetarium. Denver Museum of Natural History, 2001 Colorado Boulevard, 80205. Robert Wallace, (303) 370-6351. Exhibits, space artifacts, tours, lectures, public observing, planetarium shows, laser shows, special children's programs. Open Tuesday-Sunday.

CONNECTICUT

Danbury — Western Connecticut State College Planetarium. 06810. Philip K. Lu, (203) 797-4218.

New Britain — Copernican Observatory and Planetarium. Central Connecticut State University, Wells Street, 06050. Craig Robinson, (203) 827-7852. Planetarium shows, observatory. Open Friday and Saturday evenings only.

Stamford — Stamford Museum and Nature Center. 39 Scofieldtown Road, 06903. Davis Mitchell, (203) 322-1646. Exhibits, space artifacts, lectures, classes, public observing, planetarium shows, observatory, open houses, special children's programs. Open Monday-Sunday.

West Hartford — Grengas Planetarium. Science Museum of Connecticut, 950 Trout Brook Drive, 06119. Francis J. Downey, (203) 236-2961.

DELAWARE

Wilmington — Mount Cuba Astronomical Observatory, Inc. P.O. Box 3915, Hillside Mill Road, 19807. (302) 654-6407. Tours, lectures, classes, public observing, planetarium shows, observatory, special children's programs. Open Monday evenings and by reservation.

DISTRICT OF COLUMBIA

Albert Einstein Planetarium. National Air and Space Museum, Smithsonian Institution, 6th Street and Independence Avenue, SW, 20560. Ellen V. Sprousl, (202) 357-7000. Exhibits, historical astronomical instruments, space artifacts, tours, lectures, classes, public observing, films, planetarium shows, IMAX theater, open houses, special children's programs. Open Monday-Sunday.

Rock Creek Nature Center. 5200 Glover Road, NW, 20015. William T. Rudolph, (202) 426-6829. Exhibits, tours, lectures, films, planetarium shows, special children's programs. Open Monday-Sunday.

U.S. Naval Observatory. 34th and Massachusetts Avenue NW, 20392. Gail S. Cleere, (202) 653-1541. Exhibits, historical astronomical instruments, tours, lectures, public observing, open houses. Open Monday evening only.

FLORIDA

Bradenton — Bishop Planetarium. 201 10th Street West, 34205. John Hare, (813) 746-4132. Exhibits, classes, public observing, planetarium shows, laser shows, observatory, special children's programs. Open Tuesday-Sunday.

Cocoa — Astronaut Memorial Hall. 1519 Clearlake Road, 32922. Mike Hutton, (305) 632-1111. Exhibits, space artifacts, public observing, films, planetarium shows, laser shows, observatory, special children's programs. Open Monday-Saturday.

Daytona Beach — Museum of Arts and Sciences Planetarium. 1040 Museum Boulevard, 32014. Lee Golden, (904) 255-0285. Exhibits, planetarium shows, laser shows, special children's programs. Open Tuesday-Saturday.

Fort Myers — Junior Museum and Planetarium of Lee County. P.O. Box 06023, 33906. June Payne, (813) 275-3183. Exhibits, tours, lectures, classes, public observing, films, planetarium shows, special children's programs. Open Wednesday-Sunday.

Jacksonville — Alexander Brest Planetarium. Jacksonville Museum of Sciences and History, 1025 Gulf Life Road, 32207. Barry Perlman, (904) 396-7062. Exhibits, historical astronomical instruments, space artifacts, tours, lectures, classes, public observing, films, planetarium shows, laser shows, special children's programs. Open Monday-Sunday.

Kennedy Space Center — NASA Kennedy Space Center's Spaceport USA. 32899. George Meguiar, (305) 452-2121. Exhibits, space artifacts, tours, lectures, public observing, films, IMAX theater, special children's programs. Open Monday-Sunday.

Melbourne — Space Coast Science Center. 1510 Highland Avenue, P.O. Box 36-1816, 32936. Robert G. Tuck, Jr., (407) 259-5572. Exhibits, classes, open houses, special children's programs. Open Tuesday-Saturday.

Miami — Miami Space Transit Planetarium. 3280 South Miami Avenue, 33129. Jack F. Horkheimer, (305) 854-4242. Exhibits, space artifacts, lectures, classes, public observing, planetarium shows, laser shows, observatory, open houses, special children's programs. Open Monday-Sunday.

Orlando — John Young Planetarium. Orlando Science Center, 810 East Rollin Street, 32803. Mike Murray, (407) 896-7151. Exhibits, lectures, classes, public observing, films, planetarium shows, laser shows, observatory, special children's programs. Open Monday-Sunday.

St. Petersburg — Science Center of Pinellas County. 7701 22nd Avenue North, 33710. Paul Lamb, (813) 384-0027. Exhibits, classes, open houses, special children's programs. Open Monday-Saturday.

Tallahassee — Florida State University Planetarium. Department of Physics, 32306. (904) 644-2098. Planetarium shows. By reservation only.

West Palm Beach — Aldrin Planetarium and Gibson Observatory. South Florida Science Museum, 4801 Dreher Trail North, 33405. Gary M. Bogner, (407) 832-1988. Exhibits, space artifacts, tours, classes, public observing, films, planetarium shows, laser shows. Open Tuesday-Sunday.

GEORGIA

Albany — Wetherbee Planetarium. 100 Roosevelt Road, 31701. Bob Dunagan, (912) 435-1572. Classes, planetarium shows, laser shows, special children's programs. Open Monday-Friday and Sunday by reservation only.

Atlanta — Fernbank Science Center. 156 Heaton Park Drive NE, 30307. Loretta Honea, (404) 378-4311. Exhibits, space artifacts, lectures, classes, public observing, films, planetarium shows, observatory, open houses, special children's programs. Open Monday-Sunday.

Columbus — Patterson Planetarium. 2900 Woodruff Farm Road, 31901. Carol Rutland Groce, (404) 568-1730. Classes, public observing, planetarium shows. By reservation only.

Macon — Mark Smith Planetarium and Observatory. 4182 Forsyth Road, 31210. Jeff Guill, (912) 477-3232. Exhibits, lectures, classes, public observing, planetarium shows, laser shows. Open Monday-Sunday.

Rock Spring — Walker County Science Center/Planetarium. P.O. Box 10, Highway 95, 30739. Wayne Robinson, (404) 762-1111. Public observing, films, planetarium shows, special children's programs. Open Monday-Friday by reservation only.

Savannah — Savannah Science Museum. 4405 Paulsen Street, 31405. Vicki Psillos, (912) 355-6705. Exhibits, lectures, classes, planetarium shows, open houses, special children's programs. Open Tuesday-Sunday.

Valdosta — Valdosta State College Planetarium and Observatory. Department of Physics, Astronomy and Geology, Valdosta State College, 31698. Martha A. Leake, (912) 333-5752. Exhibits, historical astronomical instruments, lectures, classes, public observing, planetarium shows, open houses. Open Monday-Friday by reservation.

Young Harris — Rollins Planetarium. Young Harris College, 30582. James R. Westlake, Jr., (404) 379-3990. Public observing, planetarium shows, laser shows. Open Friday.

SPEND THE NIGHT observing with McDonald Observatory's 107-inch telescope in Fort Davis, Texas, at monthly public nights.

HAWAII

Hilo — Mauna Kea Observatory. 177 Makaala Street, 96720. (808) 935-3371.

Honolulu — Bernice P. Bishop Museum and Planetarium. 1525 Bernice Street, P.O. Box 19000-A, 96817. Ken Miller, (808) 847-3511. Exhibits, public observing, planetarium shows, observatory. Open Monday-Saturday.

IDAHO

Rexburg — Ricks College Planetarium. 83440. Ellis Miller, (208) 356-1910. Exhibits, classes, public observing, films, planetarium shows, observatory. By reservation only.

ILLINOIS

Champaign — William M. Staerkel Planetarium. Parkland College, 2400 West Bradley Avenue, 61821. David A. Linton, (217) 351-2687. Lectures, public observing, films, planetarium shows, special children's programs. Open Thursday-Sunday.

Chicago — The Adler Planetarium. 1300 South Lake Shore Drive, 60605. Martha Benaroya, (312) 322-0304. Exhibits, historical astronomical instruments, space artifacts, classes, public observing, planetarium shows, observatory, special children's programs. Open Monday-Sunday.

Chicago — Museum of Science and Industry and Crown Space Center. 57th Street and Lake Shore Drive, 60637. Steve Bishop, (312) 684-1414. Exhibits, space artifacts, lectures, classes, OMNIMAX theater. Open Monday-Sunday.

Dekalb — Northern Illinois University. Physics Department Observatory, 60116. (815) 753-1772.

Evanston — Northwestern University. 2145 Sheridan Road, 60201. Melville P. Ulmer, (312) 491-5633.

Normal — Illinois State University Physics Department Planetarium. 61761-6901. Carl J. Wenning, (309) 438-2496. Public observing, planetarium shows, special children's programs. Open Monday and Wednesday evenings.

Peoria — Lakeview Museum of Arts and Sciences Planetarium. 1125 West Lake Avenue, 61614. Sheldon Schafer, (309) 686-7000. Planetarium shows, special children's programs. Open Tuesday-Thursday, Saturday and Sunday.

River Grove — Cernan Earth and Space Center. Triton College, 2000 Fifth Avenue, 60171. Bart Benjamin, (312) 456-5815. Exhibits, space artifacts, lectures, public observing, films, planetarium shows, laser shows, open houses, special children's programs. Open Monday-Sunday.

Rockford — The Time Museum. 7801 East State Street, P.O. Box 5285, 61125. Dorothy Mastricola, (815) 398-6000. Exhibits, historical astronomical instruments, tours, films. Open Tuesday-Sunday.

INDIANA

Evansville — Koch Science Center and Planetarium. 411 SE Riverside Drive, 47713. Mitch Luman, (812) 425-2406. Exhibits, tours, lectures, classes, planetarium shows, special children's programs. Open Tuesday-Sunday.

Fort Wayne — E. C. Schouweiler Planetarium. Saint Francis College, 2701 Spring Street, 46806. Albert L. Hennig. Classes, planetarium shows, special children's programs. By reservation only.

Greencastle — McKim Observatory. DePauw University, 46135. Mary P. Kertzman, (317) 658-4648. Historical astronomical instruments, tours, public observing, open houses. By reservation only.

Marshall — Nature Center Planetarium. Turkey Run State Park, Rural Route 1, Box 164, 47859. Marquita Manley, (317) 597-2654. Exhibits, films, planetarium shows. Open Monday-Sunday.

Muncie — Ball State University. Department of Physics and Astronomy, 47306. Roger Scott, (317) 285-8860. Lectures, classes, public observing, planetarium shows, observatory. Open Monday-Friday.

Terre Haute — Indiana State University Observatory. 47809. Robert C. Howe, (812) 237-2271.

IOWA

Cherokee — Sanford Museum and Planetarium. 117 East Willow Street, 51012. Terry Walker, (712) 225-3922. Exhibits, planetarium shows. Open Monday-Sunday.

Des Moines — Drake University. 50311. Dr. Staunton, (515) 271-3141. Lectures, public observing, observatory, open houses. Open Friday evenings.

Des Moines — The Science Center of Iowa. Sargent Planetarium, 4500 Grand Avenue, 50312. Morris H. Mason, (515) 274-4138. Exhibits, historical astronomical instruments, lectures, classes, planetarium shows, open houses, special children's programs. Open Monday-Sunday.

Dubuque — Heitkamp Memorial Planetarium. Loras College, 52004-0178. Frank Miller, (319) 588-7154. Exhibits, classes, public observing, planetarium shows, special children's programs. Open Friday evening and by reservation.

Waterloo — Grout Museum of History and Science. 503 South Street, 50701. Alinda Wengenroth, (319) 234-6357. Planetarium shows, special children's programs. Open Tuesday-Saturday.

KANSAS

Great Bend — Barton County Community College Planetarium. Bissells Point Road, 67530. Richard Cordaro, (316) 792-2701. Planetarium shows. By reservation only.

Greensburg — Pallasite Meteorite. The Big Well, 315 South Sycamore, 67054. Mary L. Keller, (316) 723-2261. Exhibits. Open Monday-Sunday.

Hutchinson — Kansas Cosmosphere and Space Center. 1100 North Plum, 67501. Ellen Walker, (316) 662-2305. Exhibits, space artifacts, tours, lectures, classes, public observing, films, plan-

etarium shows, OMNIMAX theater, open houses, special children's programs. Open Monday-Sunday.

Lawrence — University of Kansas. Department of Physics and Astronomy, 66045-2151. Tours, lectures, classes, public observing, observatory, open houses, special children's programs. Open Fridays by reservation only.

Wichita — Lake Afton Public Observatory. 1845 Fairmont, 67208. Greg Novacek, (316) 794-8995. Exhibits, public observing. Open Friday-Sunday evenings.

Wichita — Omnisphere and Science Center. 220 South Main Street, 67202. Jose Olivarez, (316) 264-3174. Exhibits, planetarium shows, special children's programs. Open Tuesday-Sunday.

KENTUCKY

Berea — Weatherford Planetarium. Berea College, CPO 1630, 40404. Smith Powell, (606) 986-9341 extension 6246. Public observing, planetarium shows, observatory. Open Saturday and Sunday evenings only.

Georgetown — Georgetown College Planetarium. 400 East College Street, 40324-1696. Daniel Gaeddert, (502) 863-8146. Planetarium shows. By reservation only.

Louisville — Museum of History and Science. 727 West Main Street, 40402. Alan Goldstein. Exhibits, space artifacts, tours, lectures, classes, public observing, films, IMAX theater, open houses, special children's programs. Open Monday-Sunday.

Louisville — Rauch Memorial Planetarium. University of Louisville, 40292. Tom Boone, (502) 588-6665. Lectures, public observing, planetarium shows, special children's programs. Open Monday-Sunday. Closed August.

Richmond — Armin D. Hummel Planetarium. Eastern Kentucky University, 40475-3127. Jack K. Fletcher, (606) 622-1547. Planetarium shows. Open Wednesday-Sunday.

LOUISIANA

Baton Rouge — Louisiana Arts and Science Center Planetarium. 502 North Boulevard, 70821. Rick Greenawald, (504) 344-9465. Public observing, planetarium shows. Open Tuesday-Sunday.

Lafayette — Lafayette Natural History Museum and Planetarium. 637 Girard Park Drive, 70503. Donna Savoie, (318) 268-5544. Exhibits, classes, public observing, films, planetarium shows. Open Monday-Sunday.

Luling — St. Charles Parish Library and Planetarium. 91 Lakewood Drive, 70070. Gary Meibaum, (504) 785-8471. Tours, lectures, public observing, films, planetarium shows, open houses, special children's programs. Open Monday-Saturday.

New Orleans — Martin Marietta/Michoud Assembly Facility. 13800 Old Gentilly Road, 70129. (504) 255-2479.

MAINE

Easton — Francis M. Malcolm Science Center Planetarium. P.O. Box 186, U.S. Route 1-A, 04740. John T. Meader, (207) 488-5451.

Orono — University of Maine Planetarium and Observatory, Wingate Hall, 04469. Alan W. Davenport, (207) 581-1341.

Portland — Southworth Planetarium. University of Southern Maine, 96 Falmouth Street, 04103. Roy A. Gallant, (207) 780-4249. Exhibits, films, planetarium shows, laser shows. Open Wednesday and Friday-Sunday evenings and by reservation.

MARYLAND

Baltimore — Community College of Baltimore Planetarium. 2901 Liberty Heights Avenue, 21215. Charles F. Robinson, (301) 396-7994. Lectures, classes, planetarium shows. By reservation only.

Baltimore — Maryland Science Center. 601 Light Street, 21230. (301) 685-5225. Exhibits, classes, planetarium shows, IMAX theater, special children's programs. Open Monday-Sunday.

College Park — University of Maryland. Astronomy Program, 1205 Space Sciences Building, 20742. John D. Tasco, (301) 454-3001. Observatory, open houses. Open 5th and 20th of each month.

Frostburg — Frostburg State University Planetarium. 21532. Robert Doyle, (301) 689-4270. Planetarium shows, special children's programs. By reservation only.

Hagerstown — Washington County Planetarium and Space Science Center. 823 Commonwealth Avenue, 21740. Rodney L. Martin, (301) 791-4172. Exhibits, planetarium shows. By reservation only.

MASSACHUSETTS

Boston — Boston University Astronomy Department. 725 Commonwealth Avenue, 02215. Frank F. Sienkiewicz, (617) 353-5700. Exhibits, historical astronomical instruments, public observing, observatory. Open Wednesday evenings only.

Boston — Charles Hayden Planetarium. Boston Museum of Science, Science Park, 02114. Larry Schindler, (617) 723-2500. Exhibits, lectures, classes, planetarium shows, laser shows, OMNIMAX theater. Open Monday-Sunday.

Cambridge — Smithsonian Astrophysical Observatory. 60 Garden Street, 02138. Caroline Lupfer, (617) 495-7461. Lectures, films, public observing, observatory. Open third Thursday evenings and by reservation.

Nantucket — Loines Observatory. Mailing address: Maria Mitchell Observatory, 3 Vestal Street, 02554. Emilia Belserene, (508) 228-9273. Public observing.

Springfield — Springfield Science Museum. 236 State Street, 01103. Sara Orr, (413) 733-1194. Exhibits, classes, public observing, planetarium shows, observatory. Open Tuesday-Sunday.

Wenham — Woodside Planetarium and Observatory. 13 Friend Court, 01984. Ray Fowler, (508) 468-4815. Lectures, classes, films, planetarium shows. By reservation only.

Williamstown — Milham Planetarium. Williams College, 01267. Jay M. Pasachoff, (413) 597-2188. Exhibits, historical astronomical instruments, public observing, planetarium shows, observatory. Open Tuesday and Thursday evenings only.

Worcester — New England Science Center. 222 Harrington Way, 01604. James David Moran, (617) 791-9211. Exhibits, lectures, classes, public observing, planetarium shows, observatory. Open Monday-Sunday.

MICHIGAN

Alpena — Jesse Besser Museum and Planetarium. 491 Johnson Street, 49707. (517) 356-2202. Exhibits, tours, lectures, classes, films, planetarium shows, open houses, special children's programs. Open Monday-Sunday.

Ann Arbor — Ruthven Planetarium Theater. University of Michigan, Natural Sciences Museums, 48109-1079. Garry F. Beckstrom, (313) 764-0478. Exhibits, lectures, classes, planetarium shows, special children's programs. Open Saturday and Sunday.

Battle Creek — Kingman Museum of Natural History. West Michigan Avenue at 20th Street, 49017. James Cogswell, (616) 965-5117. Exhibits, space artifacts, classes, public observing, films, planetarium shows, open houses, special children's programs. Open Monday-Sunday.

Bloomfield Hills — Cranbrook Institute of Science. 500 Lone Pine Road, 48013. Jeffery Bass, (313) 645-3200. Exhibits, lectures, classes, public observing, planetarium shows, laser shows, observatory. Open Monday-Sunday.

Detroit — Children's Museum/Detroit Public Schools. 67 East Kirby, 48202. Beatrice Parsons, (313) 494-1210. Exhibits, classes, films, planetarium shows, open houses, special children's programs. Open Monday-Friday.

Detroit — Detroit Science Center. 5020 John R. Street, 48202. John Zawiskie, (313) 577-8430. Exhibits, classes, public observing, planetarium shows, laser shows, OMNIMAX theater, special children's programs. Open Tuesday-Sunday.

East Lansing — Abrams Planetarium. Michigan State University, 48824. David Batch, (517) 355-4676. Exhibits, historical astronomical instruments, space artifacts, classes, public observing, planetarium shows, special children's programs. Open Monday-Sunday.

Flint — Robert T. Longway Planetarium. 1310 East Kearsley Street, 48503. Michael Gardner, (313) 762-1181. Exhibits, space artifacts, tours, lectures, public observing, planetarium shows, special children's programs. Open Monday-Sunday.

Grand Rapids — Roger B. Chaffee Planetarium. Grand Rapids Public Museum, 54 Jefferson SE, 49503. David L. DeBruyn, (616) 456-3200. Exhibits, space artifacts, tours, public observing, planetarium shows, laser shows, special children's programs. Open Monday-Sunday.

Kalamazoo — Hans Baldauf Planetarium. Kalamazoo Public Museum, 315 South Rose Street, 49007. Eric Schreur, (616) 345-7092. Exhibits, planetarium shows, special children's programs. Open Tuesday-Saturday.

BEAM DOWN to the surface of Mars, Jupiter, and the Moon with "space transporters" at Adler Planetarium in Chicago.

Lansing — Impression Five Science Museum. 200 Museum Drive, 48933. Kelli Kinder, (517) 485-8116. Exhibits, classes, public observing, films, special children's programs. Open Monday-Sunday.

Marquette — Shiras Planetarium. Marquette Senior High School, 1203 West Fair Avenue, 49855. D. Scott Stobbelaar, (906) 225-4204.

Mount Pleasant — Brooks Observatory. Central Michigan University, 48859. Wayne Osborn, (517) 774-3SKY. Classes, observatory, open houses. By reservation.

MINNESOTA

Duluth — Alworth Planetarium. University of Minnesota-Duluth, 55812. Glenn Langhorst, (218) 726-7129. Exhibits, classes, planetarium shows. Open Monday-Thursday.

Hibbing — Paulucci Space Theater. Arrowhead Community College Region, P.O. Box 186, 55746. Dale Gibbs, (218) 262-6720. Exhibits, tours, films, planetarium shows. Open Monday-Sunday.

Minneapolis — Minneapolis Planetarium. 300 Nicollet Mall, 55401. Rodney M. Nerdahl, (612) 372-6644. Exhibits, planetarium shows, special children's programs. Open Monday-Sunday.

Moorhead — Moorhead State University Planetarium. 8th Avenue and 11th Street S, 56560.

David Weinrich, (218) 236-3982. Public observing, planetarium shows, special children's programs. Open Thursday and by reservation.

New Ulm — Dr. Martin Luther College. 1884 College Heights, 56073. John Paulsen, (507) 354-8221. Planetarium shows. By reservation only.

St. Cloud — St. Cloud State University Observatory and Planetarium. 56301. David Targan, (612) 255-2013. Classes, public observing, planetarium shows, observatory, special children's programs. By reservation only.

MISSISSIPPI

Jackson — Ronald E. McNair Space Theater. Russell Davis Planetarium, 201 East Pascagoula Street, 39201. Mary Herron, (601) 960-1550. Exhibits, historical astronomical instruments, space artifacts, films, planetarium shows, laser shows, special children's programs. Open Tuesday-Sunday.

MISSOURI

Kansas City — Kansas City Museum Planetarium. 3218 Gladstone Boulevard, 64123. Leo Hirner, (816) 483-8300. Planetarium shows, special children's programs. Open Tuesday-Sunday.

A RARE CLOSE-UP look at the world of modern astronomy awaits you at Kitt Peak National Observatory near Tucson, Arizona.

St. Louis — St. Louis Science Center. 5100 Clayton Road, Forest Park, 63110. John Wharton, (314) 289-4444. Exhibits, space artifacts, public observing, planetarium shows, special children's programs. Open Monday-Sunday.

NEBRASKA

Hastings — J. M. McDonald Planetarium. Hastings Museum, 1330 North Burlington Avenue, 68901. Dan Glomski, (402) 461-2399. Exhibits, space artifacts, planetarium shows. Open Monday-Sunday.

Lincoln — Ralph Mueller Planetarium. University of Nebraska State Museum, 210 Morrill Hall, 14th and U, 68588-0338. Jack Dunn, (402) 472-2641. Planetarium shows, laser shows. Open Tuesday-Sunday.

NEVADA

Las Vegas — Clark County Community College Planetarium. 3200 East Cheyenne Avenue, 89030. Dale A. Etheridge, (702) 644-5059. Public observing, films, planetarium shows. Open Thursday-Saturday.

Reno — Fleischmann Planetarium. University of Nevada-Reno, 1650 North Virginia Street, 89557. Art Johnson, (702) 784-4812. Exhibits, space artifacts, public observing, films, planetarium shows. Open Monday-Sunday.

NEW HAMPSHIRE

Hanover — Shattuck Observatory. Dartmouth College, Physics and Astronomy Department, Wilder Hall, 03755. Thomas O. Kenyon, (603) 646-2034. Public observing. By reservation only.

NEW JERSEY

Mountainside — Trailside Planetarium. Trailside Nature and Science Center, Coles Avenue and New Providence Road, 07092. Lonny Buinis, (201) 789-3670. Classes, public observing, planetarium shows, special children's programs. Open Monday-Thursday and Sunday.

Newark — Newark Museum Planetarium. 43-53 Washington Street, 07101. Jerome Vinski, (212) 596-6609. Public observing, planetarium shows, special children's programs. Open Tuesday-Sunday.

Randolph — County College of Morris Planetarium. Route 10 and Center Grove Road, 07869. John Coolbaugh, (201) 361-5000 extension 368. Planetarium shows. Open Friday and Saturday.

Toms River — Robert J. Novins Planetarium. Ocean County College, 08754-2001. R. Erik Zimmermann, (201) 255-0343. Planetarium shows, special children's programs.

NEW MEXICO

Alamogordo — The Space Center. Top of New Mexico Highway 2001, Box 533, 88310. Arthur G. Barton, (505) 437-2840. Exhibits, space artifacts, tours, lectures, classes, films, planetarium shows, laser shows, OMNIMAX theater, special children's programs. Open Monday-Sunday.

Albuquerque — University of New Mexico. Department of Physics and Astronomy, 800 Yale Boulevard NE, 87131. Bel Campbell, (505) 277-2616. Public observing, observatory. Open Friday and by reservation.

Socorro — National Radio Astronomy Observatory. P.O. Box O, 87801-0387. Robert Havlen, (505) 772-4011. Exhibits, tours, observatory. Open Monday-Sunday.

NEW YORK

Alfred — Alfred University. 14802. John Stull, (607) 871-2208. Public observing, observatory, open houses.

Binghamton — Link Planetarium-Kopernik Observatory. 30 Front Street, 13905. William L. Buckingham, (607) 772-0660. Exhibits, tours, lectures, classes, public observing, films, planetarium shows, open houses. Open Tuesday-Sunday.

Buffalo — Ferguson Planetarium. State University College at Buffalo, 1300 Elmwood Avenue, 14222. Arthur Gielow, (716) 878-4911. Public observing, planetarium shows. By reservation only.

Centerport — Vanderbilt Planetarium. 178 Little Neck Road, 11721. Mark Levine, (516) 262-7800. Exhibits, tours, lectures, classes, public observing, planetarium shows, observatory, special children's programs. Open Tuesday-Sunday.

Fredonia — Planetarium. SUNY College at Fredonia, 14063. Daniel C. Dobey, (716) 673-3370.

Herkimer — Herkimer County BOCES Planetarium. 400 Gros Boulevard, 13350. Theodore Stalec, (315) 867-2088. Classes, planetarium shows. Open Monday-Friday by reservation only.

Ithaca — Cornell University. 14853. Yervant Terzian, (607) 255-4206. Classes, public observing, observatory.

Ithaca — Spacecraft Planetary Imaging Facility. Cornell University, 317 Space Sciences Building, 14850. Margaret Dermott, (607) 255-3833.

Middle Island — Longwood District Planetarium. Middle Island-Yaphank Road, 11953. Joseph E. Caprioglio, (516) 345-2741. Lectures, classes, public observing, planetarium shows.

New York — American Museum/Hayden Planetarium. Central Park West at 81st Street, 10024-5192. William Gutsch, (212) 769-5900. Exhibits, historical astronomical instruments, space artifacts, classes, planetarium shows, laser shows, special children's programs. Open Monday-Sunday.

Poplar Ridge — Southern Cayuga Atmospherium-Planetarium. 13139. Steven L. J. Russo, (315) 364-7111. Lectures, public observing, films, planetarium shows, open houses. Open Saturdays and by reservation.

Potsdam — Potsdam College of Arts and Sciences. State University of New York, 13676. (315) 267-2284. Tours, lectures, classes, public observing, planetarium shows. By reservation only.

Rochester — Strasenburgh Planetarium. Rochester Museum and Science Center, 657 East Avenue, 14607. Donald S. Hall, (716) 271-4320. Exhibits, historical astronomical instruments, classes, public observing, planetarium shows, laser shows, observatory, special children's programs. Open Monday-Sunday.

Schenectady — Schenectady Museum and Planetarium. Nott Terrace Heights, 12308. Susan C. French, (518) 382-7890. Exhibits, tours, lectures, classes, planetarium shows, special chidren's programs. Open Tuesday-Sunday.

Staten Island — Wagner College Planetarium. 631 Howard Avenue, 10301. Paul Albicocco, (718) 390-3341. Planetarium shows. Open Monday-Friday by reservation only.

Syracuse — Discovery Center of Science and Technology. 321 South Clinton Street, 13202. Stephen A. Karon, (315) 425-9068. Exhibits, space artifacts, lectures, classes, public observing, films, planetarium shows, special children's programs. Open Tuesday-Sunday.

Troy — The Junior Museum. 282 5th Avenue, 12182. Margo Olson, (518) 235-2120. Exhibits, tours, lectures, classes, planetarium shows, special children's programs. Open Monday-Wednesday, Saturday, and Sunday.

Yonkers — Andrus Planetarium. 511 Warburton Avenue, 10701. Jon Elvert, (914) 963-4550. Exhibits, lectures, classes, public observing, films, planetarium shows, observatory, special children's programs. Open Wednesday-Sunday.

NORTH CAROLINA

Chapel Hill — Morehead Planetarium. University of North Carolina-Chapel Hill, Morehead Building, CB 3480, 27599-3480. Lee T. Shapiro, (919) 962-1236. Exhibits, historical astronomical instruments, space artifacts, classes, public observing, films, planetarium shows, laser shows, observatory, special children's programs. Open Monday-Sunday.

Charlotte — Discovery Place and Nature Museum. 301 North Tryon Street, 28202. Michael Blanton, (704) 372-6261. Exhibits, tours, classes, public observing, films, planetarium shows, special children's programs. Open Monday-Sunday.

Greensboro — Edward Zane Planetarium. The Natural Science Center of Greensboro, 4301 Lawndale Drive, 27408. Roger D. Joyner, (919) 288-3769. Exhibits, historical astronomical instruments, space artifacts, classes, public observing, planetarium shows, open houses, special children's programs. Open Monday-Sunday.

Greensboro — Three College Observatory. University of North Carolina-Greensboro, Department of Physics and Astronomy, 27412. Stephen Danford, (919) 334-5669. Public observing. By reservation only.

Salisbury — Margaret C. Woodson Planetarium/Horizons Unlimited-Supplementary Education Center. 1636 Parkview Circle, 28144. Ellen Trex-

ler, (704) 636-3462. Exhibits, historical astronomical instruments, space artifacts, tours, lectures, classes, public observing, films, planetarium shows, observatory, open houses, special children's programs. Open Monday-Sunday.

Winston-Salem — Nature Science Center. Museum Drive, 27105. Pat Fromen, (919) 767-6730. Exhibits, public observing, planetarium shows, special children's programs. Open Monday-Sunday.

NORTH DAKOTA

Grand Forks — University of North Dakota Atmospherium. Center for Aerospace Studies, P.O. Box 8216, University Station, 58202. Leon F. Osborne, (701) 777-2184. Exhibits, space artifacts, tours, films, planetarium shows. Open Thursday-Sunday.

Minot — Minot State University. 500 University Avenue West, 58701. DeWayne Martin, (701) 857-3071. Public observing, observatory.

OHIO

Bay Village — Schuele Planetarium. 28728 Wolf Road, 44140. Bill Kobel, (216) 835-9912. Planetarium shows, special children's programs. Open Sunday.

Canton — Hoover-Price Planetarium. McKinley Museum, 800 McKinley Monument Drive, 44701. J. W. Mahoney, (216) 455-7043. Exhibits, space artifacts, tours, lectures, classes, planetarium shows, special children's programs. Open Monday-Sunday.

Cincinnati — Cincinnati Museum of Natural History and Planetarium. 1720 Gilbert Avenue, 45202. Roberta Burnes, (513) 621-3889. Exhibits, lectures, classes, planetarium shows, special children's programs. Open Tuesday-Sunday.

Cincinnati — University of Cincinnati Observatory. 3489 Observatory Place, 45208. Paul Nohr, (513) 321-5186. Exhibits, historical astronomical instruments, tours, lectures, classes, public observing, films, open houses, special children's programs. Open Thursday evenings and by reservation.

Cleveland — Cleveland Museum of Natural History/Mueller Planetarium. Wade Oval, University Circle, 44106. Joseph DeRocher, (216) 231-4600. Exhibits, public observing, planetarium shows, observatory, special children's programs. Open Monday-Sunday.

Cleveland — Visitor Center at NASA's Lewis Research Center. 21000 Brookpark Road MS 8-1, 44135. (216) 433-2001. Exhibits, space artifacts, tours, lectures, classes, videos, special children's programs. Open Monday-Sunday.

Columbus — Battelle Planetarium. Center of Science and Industry, 280 East Broad Street, 43215. Sandy C. Hallock, (614) 228-6362.

Dayton — Dayton Museum of Natural History. 2629 Ridge Avenue, 45414. Arthur F. Goss, (513) 275-7431. Exhibits, historical astronomical instruments, lectures, classes, public observing, films, planetarium shows, observatory, special children's programs. Open Monday-Sunday.

Granville — Swasey Observatory. Denison University, 43023. Sandra Yorka, (614) 587-6477. Tours, public observing, open houses. Open Monday-Friday.

Sylvania — Copernicus Planetarium. Lourdes College, 6832 Convent Boulevard, 43560-2898. Anthony G. Pisano, (419) 885-3211 Exhibits, space artifacts, tours, lectures, planetarium shows, special children's programs. Open Monday-Saturday.

Westerville — North American Astrophysical Observatory. Otterbein College, 43081. Phillip Barnhart, (614) 898-1516.

Youngstown — Youngstown State University Planetarium. Department of Physics, 410 Wick Avenue, 44555. Warren Young, (216) 742-3616. Public observing, planetarium shows, laser shows, observatory. Open Friday and Saturday.

OKLAHOMA

Fort Sill — Fort Sill Planetarium. Target Acquisition Department, Survey Division, 73503. London Hill, (405) 351-6616. Planetarium shows, special children's programs. Open Monday-Friday by reservation only.

Oklahoma City — Kirkpatrick Planetarium. 2100 NE 52, 73111. Wayne Wyrick, (405) 424-5545. Exhibits, space artifacts, lectures, public observing, planetarium shows, laser shows, observatory. Open Monday-Sunday.

OREGON

Bend — University of Oregon Pine Mountain Observatory. Bend-Burns Star Route, 97702. David K. McDaniels, (503) 382-8331. Tours, lectures, public observing. Open Friday-Sunday evenings and by reservation.

Portland — Oregon Museum of Science and Technology/Kendall Planetarium. 4015 SW Canyon Road, 97221. Jan Paul Dabrowski, (503) 222-2828. Exhibits, space artifacts, lectures, classes, public observing, planetarium shows, laser shows, special children's programs. Open Monday-Sunday.

Salem — Chemetka Community College Planetarium. 4000 Lancaster Drive NE, P.O. Box 14007, 97309. Tom McDonough, (503) 399-5761. Lectures, classes, public observing, films, planetarium shows, special children's program. Open Friday-Saturday.

PENNSYLVANIA

Edinboro — Edinboro University Observatory. Edinboro University of Pennsylvania, 16444. Patti Loomis, (814) 732-2745. Exhibits, classes, public observing, planetarium shows, observatory. Open Monday-Wednesday.

Erie — Erie Historical Museum and Planetarium. 356 West 6th Street, 16507. Gloria D. Rall, (814) 453-5811. Exhibits, planetarium shows. Open Tuesday-Sunday.

Harrisburg — State Museum of Pennsylvania Planetarium. Box 1026, 3rd and North Streets, 17108. Jeffrey L. Smith, (717) 783-9914. Exhibits, classes, planetarium shows, special children's programs. Open Tuesday-Sunday.

Lancaster — North Museum Planetarium. Franklin and Marshall College, 17604. Jordan Marche, (717) 291-4315. Exhibits, public observing, planetarium shows, observatory. Open Wednesday-Sunday.

Lewisburg — Bucknell University Observatory. Bucknell University, Department of Physics, 17837. Anthony J. Nicastro, (717) 524-1139. Exhibits, historical astronomical instruments, lectures, public observing, open houses. Open by reservation only.

Lock Haven — Ulmer Planetarium. Lock Haven University, 17745. Donald L. Brobst, (717) 893-2075.

Philadelphia — Franklin Institute/Fels Planetarium. 20th and the Parkway, 19103. Derrick Pitts, (215) 448-1293. Exhibits, space artifacts, lectures, classes, public observing, planetarium shows, observatory, special children's programs. Open Monday-Sunday.

Pittsburgh — Allegheny Observatory. 159 Riverview Avenue, 15214. Nancy Robinson, (412) 321-2400.

Pittsburgh — Buhl Science Center. Allegheny Square, 15212. Mary Pat McCarthy, (412) 321-4302. Exhibits, tours, lectures, classes, public observing, films, planetarium shows, laser shows, observatory, open houses, special children's programs. Open Monday-Sunday.

THE SKY COMES ALIVE under the planetarium dome at Discovery Place/Nature Museum in Charlotte, North Carolina.

Reading — Reading School District Planetarium. 1211 Parkside Drive South, 19611-1441. Kathleen L. Raffaelli, (215) 371-5854. Classes, exhibits, planetarium shows, special children's programs. Open Monday-Friday.

Scranton — Everhart Museum Planetarium. Nay Aug Park, 18510. William Speare, (717) 346-8370. Exhibits, lectures, planetarium shows. Open Tuesday-Friday by reservation.

Villanova — Planetarium and Observatory. Villanova University, Department of Astronomy and Astrophysics, 19085. (215) 645-4820.

West Chester — West Chester State University. Department of Geology and Astronomy, Rosedale and South Church Streets, 19383. Hubert Harber, (215) 436-2721. Public observing, planetarium shows, observatory, special children's programs. By reservation only.

Williamsport — Detwiler Planetarium. Lycoming College, 17701. Richard Erickson, (717) 321-4284. Lectures, planetarium shows. By reservation only.

RHODE ISLAND

Providence — Cormack Planetarium. Museum, Roger Williams Park, 02905. Francine Jackson, (401) 785-9450.

Providence — Ladd Observatory. 210 Doyle Avenue, 02912. Hendrik J. Gerristen, (401) 863-1488.

SOUTH CAROLINA

Columbia — Gibbes Planetarium. 1112 Bull Street, 29201. Richard McColman, (803) 799-2810. Planetarium shows. Wednesday evening, Saturday and Sunday.

Florence — Francis Marion College Planetarium. 29501. Ed Dooley, (803) 661-1250. Public observing, planetarium shows, observatory.

Greenville — Roper Mountain Science Center/Daniel Observatory. 504 Roper Mountain Road, 29615. Doug Gegen, (803) 297-0232. Historical astronomical instruments, public observing, open houses. Open Friday evenings by reservation and second Saturday of the month in the afternoon.

Orangeburg — Stanback Museum and Planetarium. South Carolina State College, 29117. (803) 536-8711. Exhibits, public observing, special children's programs. Open Monday-Friday.

Rock Hill — Settlemyre Planetarium. Museum of York County, 4621 Mount Gallant Road, 29730. M. Leon Knott, (803) 329-2121. Exhibits, tours, lectures, classes, public observing, films, planetarium shows, open houses, special children's programs. Open Tuesday-Sunday.

TENNESSEE

Brentwood — A. J. Dyer Observatory. Vanderbilt University, 1000 Oman Drive, 37027. Douglas S. Hall, (615) 373-4897. Tours, observatory, open houses, special children's programs. Open Monday-Friday.

Kingsport — Bays Mountain Planetarium and Nature Center. Route 4, 37660. (615) 229-9447. Exhibits, planetarium shows, laser shows. Open Monday-Sunday.

Memphis — Memphis Pink Palace Museum and Planetarium. 3050 Central Avenue, 38111. George Brown, (901) 454-5609.

Murfreesboro — Middle Tennessee State University. 37130. Don Scott, (615) 898-2956. Classes, public observing, observatory.

Nashville — Stevenson Center Observatory. Vanderbilt University, 37235. Douglas S. Hall, (615) 373-4897. Historical astronomical instruments, observatory, open houses, special children's programs. Open Monday-Friday.

Nashville — Sudekum Planetarium. Cumberland Science Museum, 800 Ridley Boulevard, 37211. Kris McCall, (615) 259-6383. Exhibits, classes, planetarium shows, special children's programs. Open Monday-Sunday.

TEXAS

Amarillo — Don Harrington Discovery Center. 1200 Streit Drive, 79106. Robert Bauman, (806) 355-9548. Exhibits, public observing, films, planetarium shows. Open Tuesday-Sunday.

Corpus Christi — Richard King High School Planetarium. 5225 Gollihar Road, 78412. Robert Wollman, (512) 992-0942. Exhibits, planetarium shows.

Dallas — Richland College Planetarium. 12800 Abrams, 75243. Bruce Davis, (214) 238-6013. Tours, lectures, classes, public observing, planetarium shows, laser shows. Open Saturday and Sunday.

Dallas — Science Place Planetarium. P.O. Box 11158, 75223. (214) 428-7200.

Dallas — St. Marks School of Texas Planetarium. 10600 Preston Road, 75230. Thomas K. McCarthy, (214) 363-0491. Public observing, planetarium shows, laser shows, observatory. By reservation only.

El Paso — El Paso Planetarium. 6531 Boeing Drive, 79925. John R. Peterson, (915) 779-4317. Exhibits, space artifacts, public observing, films, planetarium shows, special children's programs. Open Monday-Friday.

Fort Davis — McDonald Observatory/W. L. Moody Visitor's Center. P.O. Box 1331, 79734. Robert Scheppler, (915) 426-3263. Exhibits, historical astronomical instruments, space artifacts, tours, lectures, public observing, films. Open Monday-Sunday.

Fort Worth — Fort Worth Noble Planetarium. Fort Worth Museum of Science and History, 1501 Montgomery Street, 76107. Don Garland, (817) 732-1631. Exhibits, space artifacts, tours, lectures, classes, public observing, films, public observing, planetarium shows, laser shows, open houses, special children's programs. Open Tuesday-Sunday.

Houston — Burke Baker Planetarium. Houston Museum of Natural Science, One Hermann Circle Drive, 77030. Carolyn Sumners, (713) 526-4273.

Houston — Lyndon B. Johnson Space Center. Olin Teague Visitor Center, 2101 NASA Road 1, Public Services Branch, AP4, 77058. Charles A. Biggs, (713) 483-4241. Exhibits, historical astronomical instruments, space artifacts, tours, lectures, public observing, films, special children's programs. Open Monday-Sunday.

Lubbock — Museum of Texas Tech University Moody Planetarium. 4th and Indiana Avenue, 79409-3191. Patricia Martin, (806) 742-2441. Exhibits, space artifacts, classes, planetarium shows, observatory, special children's programs. Open Tuesday-Sunday.

Odessa — Odessa Meteor Crater. 1204 Texas Commerce Bank Building, 79761. Thomas E. Rodman, (915) 332-1666. Exhibits. Open Monday-Sunday.

San Angelo — Angelo State University Planetarium. 76909. Mark S. Sonntag, (915) 942-2136. Exhibits, public observing, planetarium shows. Open Monday-Saturday.

San Antonio — San Antonio College Planetarium. 1300 San Pedro Avenue, 78284. Bryan A. Snow, (512) 733-2910. Exhibits, lectures, public observing, planetarium shows, observatory, special children's programs. Open by reservation only.

Tyler — Hudnall Planetarium. Tyler Junior College, P.O. Box 9020, 75711. Bill Walker, (214) 531-2312. Exhibits, classes, public observing, planetarium shows. Open Monday-Thursday and Sunday.

UTAH

Provo — Sarah Summerhays Planetarium. Brigham Young University, 492 ESC, 84602. Irvin Bassett, (801) 378-2805. Lectures, public observing, planetarium shows, observatory. Open Friday evenings and by reservation.

Salt Lake City — Hansen Planetarium. 15 South State Street, 84111. Doug Lowe, (801) 538-2104. Exhibits, historical astronomical instruments, space artifacts, tours, lectures, classes, planetarium shows, laser shows. Open Monday-Sunday.

VERMONT

St. Johnsbury — Fairbanks Museum and Planetarium, Main Street, 05819. Mark Breen, (802) 748-2372.

VIRGINIA

Ashland — Keeble Observatory. Randolph Macon College, 23005. George F. Spagna, Jr., (804) 798-8372. Public observing, open houses. Open by reservation only.

Charlottesville — Leander McCormick Observatory. University of Virginia, Department of Astronomy, P.O. Box 3818, 22903. Philip Ianna, (804) 924-7494. Public observing. Open first and third Fridays of each month.

Fort Union — Wicker Planetarium. Fort Union Military Academy, P.O. Box 278, Route 15, 23055. Billy Ozment, (804) 842-3082.

Hampton — NASA Langley Visitor Center. Mail Stop 480, 23665. Ray Goodman, (804) 865-2855. Exhibits, space artificats, tours, lectures, films. Open Monday-Sunday.

Harrisonburg — John C. Wells Planetarium. James Madison University, 22801. John Wells, (703) 568-6109. Planetarium shows.

Newport News — Planetarium of the Virginia Living Museum. 524 J. Clyde Morris Boulevard, 23601. Jon U. Bell, (804) 595-1900. Exhibits, lectures, classes, public observing, planetarium shows, observatory, open houses, special children's programs. Open Monday-Sunday.

Richmond — Science Museum of Virginia/Universe Space Theater, 2500 West Broad Street, 23220. Margaret D. Austin, (804) 257-1657.

Roanoke — Science Museum of Western Virginia and Hopkins Planetarium. One Market Square, 24011. Linda Van Luik. Exhibits, tours, lectures, classes, public observing, films, planetarium shows. Open Tuesday-Sunday.

Virginia Beach — Virginia Beach City Public Schools Planetarium. 3080 South Lynnhaven Road, 23451. Herbert Teuscher, (804) 431-4067. Exhibits, lectures, classes, planetarium shows, open houses. Open Sunday and Tuesday.

Wallops Island — Wallops Flight Facility's NASA Visitor Center. 23337. Keith A. Koehler, (804) 824-1344. Exhibits, space artifacts, tours, lectures, films, special children's programs. Open Monday-Sunday (June 22-September 4).

WASHINGTON

Bellevue — Bellevue Community College. 3000 Landerholm Circle, 98007. Jim Rostirolla, (206) 641-2321. Lectures, classes, public observing, planetarium shows, special children's programs. By reservation.

Cheney — Eastern Washington Science Center. Riverfront Park, 99004. Eileen M. Starr, (509) 359-6391. Exhibits, lectures, classes, planetarium shows. Open Monday-Sunday.

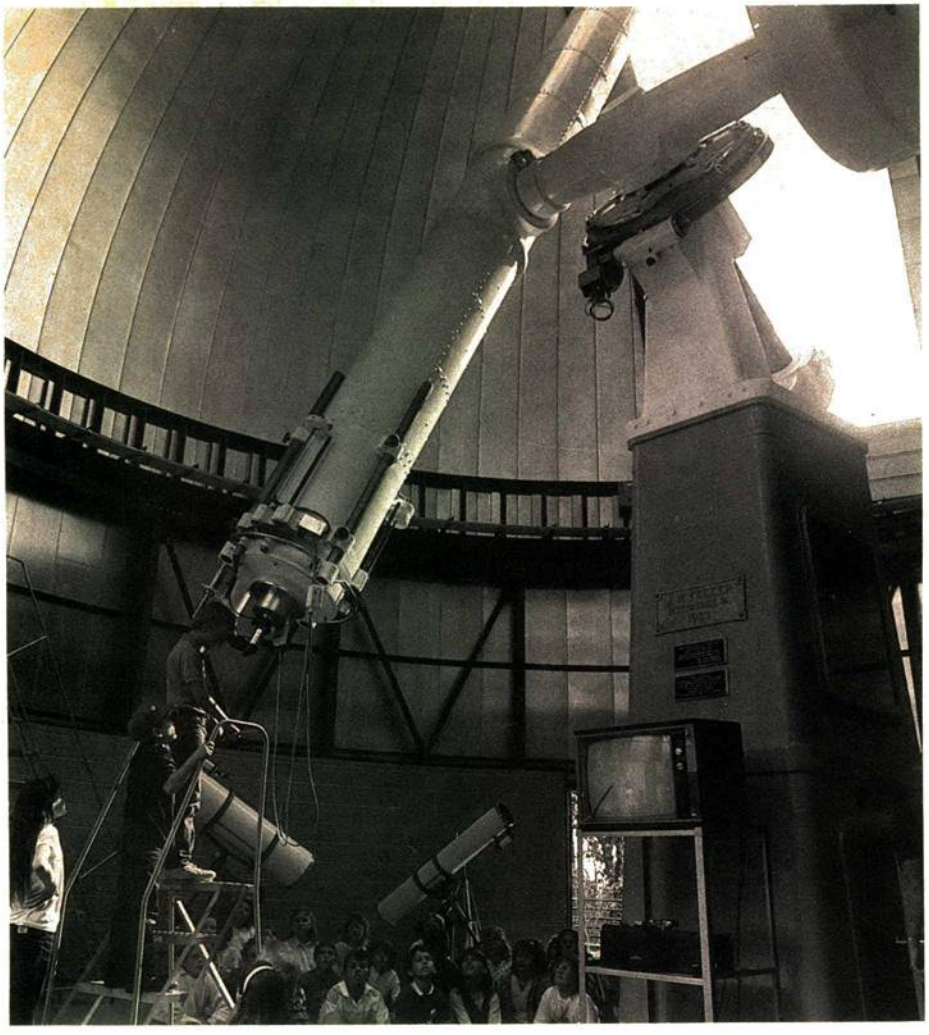
Goldendale — Goldendale Observatory. Goldendale Observatory State Park, 1602 Observatory Drive, 98620. Stephen R. Stout, (509) 773-3141. Exhibits, tours, lectures, classes, public observing, films. Open Wednesday-Sunday.

Seattle — Pacific Science Center. 200 Second Avenue North, 98109. Becky Rueter, (206) 433-2001. Exhibits, classes, planetarium shows, laser shows, IMAX theater, special children's programs. Open Monday-Sunday.

Spokane — Eastern Washington Science Center. Riverfront Park, 99202. Eileen Starr, (509) 359-6391. Exhibits, lectures, classes, planetarium shows, special children's programs. Open Monday-Sunday.

WEST VIRGINIA

Charleston — Sunrise Children's Museum Planetarium. 746 Myrtle Road, 25314. Greg Rawlings,



A HISTORICAL CLARK REFRACTOR is used for public observing at the Roper Mountain Science Center in Greenville, South Carolina.

(304) 344-8035. Exhibits, classes, public observing, planetarium shows, special children's programs. Open Wednesday, Friday, and Saturday.

Davis — Blackwater Falls State Park. P.O. Box 490, 26260. Pat Northeimer, (304) 259-5216.

Green Bank — National Radio Astronomy Observatory. P.O. Box 2, 24944-0002. (304) 456-2011. Exhibits, historical astronomical instruments, tours, films. Open Monday-Sunday mid-June through mid-August.

Wheeling — Benedum Natural Science Center. Oglebay Park, 26003. Steven Mitch, (304) 242-3000 extension 261. Exhibits, lectures, classes, public observing, films, planetarium shows, laser shows, observatory, special children's programs. Open Monday-Sunday.

WISCONSIN

Fall Creek — Beaver Creek Reserve. Box 94, 54742. Bob Elliott, (715) 877-2212 Public observing, observatory, open houses.

La Crosse — University of Wisconsin-La Crosse Planetarium. Cowley Hall, 54601. Robert Allen, (608) 788-8669.

Madison — Washburn Observatory. University of Wisconsin-Madison, 1401 Observatory Drive, 53704. (608) 262-WASH. Public observing. Open Wednesday evenings.

Milwaukee — Milwaukee Public Museum. 800 West Wells Street, 53233. (414) 278-2702. Exhibits, tours, lectures, classes, films, special children's programs. Open Monday-Sunday.

Milwaukee — University of Wisconsin-Milwaukee Planetarium, 1900 East Kenwood, 53211.

Stevens Point — University of Wisconsin-Stevens Point. Science Building, 740 Reserve Street, 54481. Randy W. Olson, (715) 346-2208. Classes, public observing, planetarium shows, observatory. Open Monday-Thursday.

Williams Bay — Yerkes Observatory. P.O. 258, 53191-0258. Richard Dreiser, (414) 245-5555.

WYOMING

Casper — Casper Planetarium. 904 North Poplar Street, 82601. Rod Robinder, (307) 557-0310. Exhibits, public observing, planetarium shows. Open Monday-Sunday evenings only.

CANADA

ALBERTA

Calgary — Centennial Planetarium. Alberta Science Center, 701-11 Street SW, P.O. Box 2100, Station M, T2P 2M5. S. Wieser, (403) 221-3700. Exhibits, planetarium shows, laser shows. Open Wednesday-Sunday.

Edmonton — Edmonton Space Sciences Centre. 11211-142 Street, T5M 4A1. Russ Sampson, (403) 452-9100. Exhibits, historical astronomical instruments, space artifacts, tours, lectures, classes, public observing, films, planetarium shows, laser shows, IMAX theater, observatory, open houses, special children's programs. Open Monday-Sunday.

BRITISH COLUMBIA

Penticon — Dominion Radio Astrophysical Observatory. National Research Council of Canada, Box 248, V2A 6K3. Erika Rohner, (604) 497-5321. Exhibits, tours. Open Monday-Sunday.

Vancouver — H. R. MacMillan Planetarium and Gordon Southam Observatory. 1100 Chestnut Street, V6J 3J9. Lynda Sawula, (604) 736-4431. Exhibits, historical astronomical instruments, space artifacts, lectures, classes, public observing, planetarium shows, laser shows. Open Monday-Sunday.

Vancouver — University of British Columbia Observatory. #143-2219 Main Mall, V6T 1W5. David Vogt, (604) 228-2802. Tours, lectures, classes, public observing, open houses, special children's programs. Open Monday-Friday.

Victoria — Climenhaga Observatory. Department of Physics and Astronomy, University of Victoria, V8W 2Y2. Russell Robb, (604) 721-7750. Tours, lectures, classes. By reservation only.

Victoria — Dominion Astrophysical Observatory. National Research Council of Canada, 5071 West Saanich Road, Victoria, V8X 4M6. (604) 388-0001. Exhibits, historical astronomical instruments, space artifacts, tours, public observing, open houses. Open Monday-Sunday.

MANITOBA

Winnipeg — Lockhart Planetarium. University of Manitoba, 380 University College, 500 Dysart Road, R3T 2M8. Ian D. Cameron, (204) 474-9785. Planetarium shows. By reservation only.

Winnipeg — Manitoba Planetarium. Museum of Man and Nature, 190 Rupert Avenue, R3B ON2. (204) 956-2830.

NOVA SCOTIA

Halifax — Burke-Gaffney Planetarium. Saint Mary's University, Department of Astronomy, B3H 3C3. Laurie Reed, (902) 429-9780.

ONTARIO

Ottawa — National Museum of Science and Technology. 1867 St. Laurent Boulevard, K1G 5A3. Michel Labrecque, (613) 998-4566. Exhibits, historical astronomical instruments, space artifacts, tours, public observing, films, observatory. Open Monday-Sunday.

Richmond Hill — David Dunlap Observatory. University of Toronto, Box 360, 123 Hillsview Drive, L4C 4Y6. Florence Unwin, (416) 884-2112. Tours, lectures, public observing. Open Tuesday and Saturday by reservation only.

Sudbury — Doran Planetarium. Laurentian University, P3E 2C6. Doug Hallman, (705) 675-1151 extension 2222. Planetarium shows, special children's programs. Monday-Friday by reservation.

Toronto — McLaughlin Planetarium. Royal Ontario Museum, 100 Queen's Park, M5S 2C6. (416) 586-5736. Exhibits, historical astronomical instruments, tours, lectures, planetarium shows, laser shows. Open Monday-Sunday.

Toronto — Ontario Science Centre. 770 Don Mills Road, M3C 1T3. Ivan Semeniuk, (416) 429-4100. Exhibits, space artifacts, public observing, films, planetarium shows. Open Monday-Sunday.

QUEBEC

Montreal — Dow Planetarium. 1000 rue de St. Jacques West, H3C 1G7. Pierre Lacombe, (514) 872-4530. Exhibits, lectures, planetarium shows, special children's programs. Open Monday-Sunday.

SASKATCHEWAN

Saskatoon — University of Saskatchewan Observatory S7N 0W0. Stan Shodick, (306) 966-6434.

Call Orion for the Largest Selection of Telescopes, Binoculars and Accessories

The Orion warehouse is packed with the best telescopes, binoculars and accessories being offered anywhere!

Over 50 Telescopes including the latest models from Meade, Celestron, Edmund Scientific and our own Orion Brand.

Over 60 Binoculars including 10 different Giant models for Astronomy and a great selection of models for birdwatching, sports and general observation.

Over 120 Eyepieces from Tele Vue, Meade, and Orion including popular Ultrascopic and Explorer Series and a wide range of specialty eyepieces.

Over 250 Useful Accessories for all telescopes. From the latest computer innovations from Meade and Celestron to many unique and necessary items that make astronomical viewing a pleasure.

Order a Free Orion Catalog Today! Put the largest selection of the best equipment in the marketplace at your fingertips – available for immediate delivery at our low discount prices!

800-447-1001

In Calif. 800-443-1001

MasterCard VISA

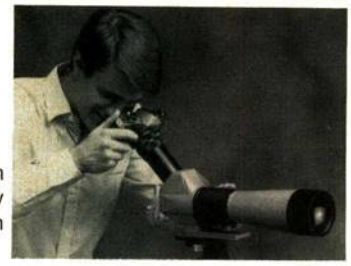
ORION TELESCOPE CENTER

Serving Amateur Astronomers Since 1975

421 Soquel Ave., Dept R, P.O. Box 1158, Santa Cruz, CA 95061

Adlerscope 80mm Spotting Scope

World's Finest Large-Aperture Multi-Purpose Telescope for Astronomy, Nature Study and General Observation



This high-resolution fully-coated 80mm refractor provides breathtaking sharp, high contrast images rivalling those of larger-aperture telescopes. Ideal for planetary astronomy, birdwatching, and any type of terrestrial observation. Silky-smooth focuser easily adjusts from 30 feet to infinity.

Larger than an ordinary spotter, the Adlerscope's big 80mm lens gathers 77% more light than 60mm models. The huge first-surface mirror image erecting system provides all the sharpness of prismatic designs, with superior image brightness and freedom from color fringing rarely seen in refractor-type spotters. The convenient 45° viewing angle is ideal for both terrestrial and astronomical observation.

The Adlerscope makes a superb 1425mm telephoto lens with the optional camera adapter. The unique sliding tripod mount base attaches to any photographic tripod and allows perfect weight balance with any eyepiece or camera adapter. Includes a wide-field 25x eyepiece for a wide 2.8° true field, 16mm eye relief and 3.2mm exit pupil. Optional camera adapter and eyepieces for 15x, 40x, and 20x-60x Zoom are listed in the Orion Catalog, page 3.

This fine telescope will impress the most discriminating and experienced observer. 20 year limited warranty. #9094 **$529** (6.98)

Improved! Field Tripod Tote Bag

Heavily padded Cordura bag with sturdy zipper holds tripod and wedge combinations for 8" and 10" Schmidt-Cassegrains. Large girth allows storage of wedge without changing polar alignment. Padded insert separates wedge from tripod during transportation. Internal pocket holds hardware.

#15096 **$77** (4.28)

Eyepiece Filter Sets Bring Out Hidden Detail

Set of 4 Color Primary Filters
#80A Blue, #58 Green, #25 Red, #15 Yellow.
#5514 **$44.95** (1.68)

Set of 4 Auxiliary Filters
#21 Orange, #47 Violet, #11 Yellow-Green, #82A Very Pale Blue.
#5516 **$44.95** (2.19)

Deluxe Set of 8 Color Filters
Includes all filters in Primary and Auxiliary Sets.
#20278 **$79** (2.79)

Available Individually
$11.95 ea. (.99)

The Dew Zapper

for 8" and 10" Schmidt-Cassegrain Telescopes

Orion's Dew Zapper is a sure-fire cure for dew problems on your 8" or 10" Celestron or Meade Schmidt-Cassegrain telescope. Dew Zapper gently replaces lost heat, bringing the corrector plate temperature back up to just above air temperature.

8" Dew Zappers
fit all Meade and Celestron 8" Schmidt-Cassegrains.

DC 8" Model #3503 **$39.95** (1.79)
AC 8" Model #3504 **$39.95** (1.79)

10" Dew Zappers
fit all Meade 10" Schmidt-Cassegrains.

DC 10" Model #3506 **$44.95** (1.79)
AC 10" Model #3508 **$44.95** (1.79)

New! Orion 16x80 Multi-Coated Giant Binoculars

45% More Power than 11x80 Models

Designed especially for observation from light polluted locations, Orion 16x80 MC binoculars provide additional image magnification without reducing brightness. When ambient light restricts dark adaptation, the larger exit pupils of 11x80 models can't be fully accommodated by the human eye, so aperture is wasted. The 5mm exit pupil of the 16x80 design is well matched to the typical dark adapted eye under these circumstances, maximizing performance. Field of view, 3.5°. Weight, 4 lb 13 oz.

Try a pair today under our 30 day money back guarantee!

#9496 **$379** (5.92)

5.0 Amp Porta Pac

Perfect for Meade LX3, LX5, LX6, and Celestron C-8, Powerstar 8 and Classic 8. Also all drive correctors and pulse motor drives. Battery is encased in high impact polystyrene, with built-in handle for easy carrying. Weighs only 5 lbs.

#2352 **$69.95** (4.56)

12 Amp Porta Pac

Ideal for operating your telescope plus higher power-consuming accessories such as an Orion Dew Zapper. Battery is encased in high impact polystyrene, and comes in a carrying case of Cordura nylon with shoulder strap. Weighs only 10 lbs.

#2354 **$89.95** (6.23)

Orion® T-Adapter

For prime focus photography. Use with T-ring to match your 35mm camera. For Meade, Celestron 8", 10" SC.

#5116 **$27.95** (1.68)

Orion® Variable Tele-Extender for Celestron or Meade

Adjustable extension tube allows you to change the magnification effect without changing eyepieces. Ideal for planetary & lunar photography with a Schmidt-Cass.

#5127 **$39.95** (1.79)

New! Orion® Balance System

Finally, a simple balance system that really works! Unlike ordinary counterweights, our system allows instant adjustment in *both* important directions, without adding or removing weights! Better than clumsy stacking weights or ordinary heavy counterweights. Easily balances your scope to offset both piggyback loads or rear-cell cameras, 2" diagonals, and other accessories. High-leverage design requires less weight than other systems. Rigid precision machined dovetail bar mounts to telescope in existing accessory holes. Black anodized aluminum and steel construction.

For Meade 8" 2080 #5150 **$74.95** (3.47)
For Celestron 8" C-8 #5149 **$79.95** (3.47)
For Meade 10" 2120 #5152 **$84.95** (3.47)

Orion Ultrascopic Eyepieces

The only ALL Multi-Coated premium eyepieces you can buy, these superb 5 to 7 element design eyepieces use modern high refractive index glasses and manufacturing methods. They provide wide, flat fields, outstanding contrast and freedom from false color.

35mm #8560 **$109** (2.34)
30mm #8562 **$99** (2.09)
25mm #8564 **$89** (2.09)
20mm #8566 **$79** (2.09)
15mm #8568 **$79** (2.09)
10mm #8570 **$79** (2.09)
7.5mm #8572 **$79** (2.09)
5.0mm #8574 **$99** (2.09)
3.8mm #8576 **$99** (2.09)

Variable Polarizing Filter Set

Rotating filter cells permit variable light transmission of 3% to 40%, or can be separated for simple glare reduction. Thread into standard eyepieces, or the diagonal prism of most telescopes before the eyepiece.

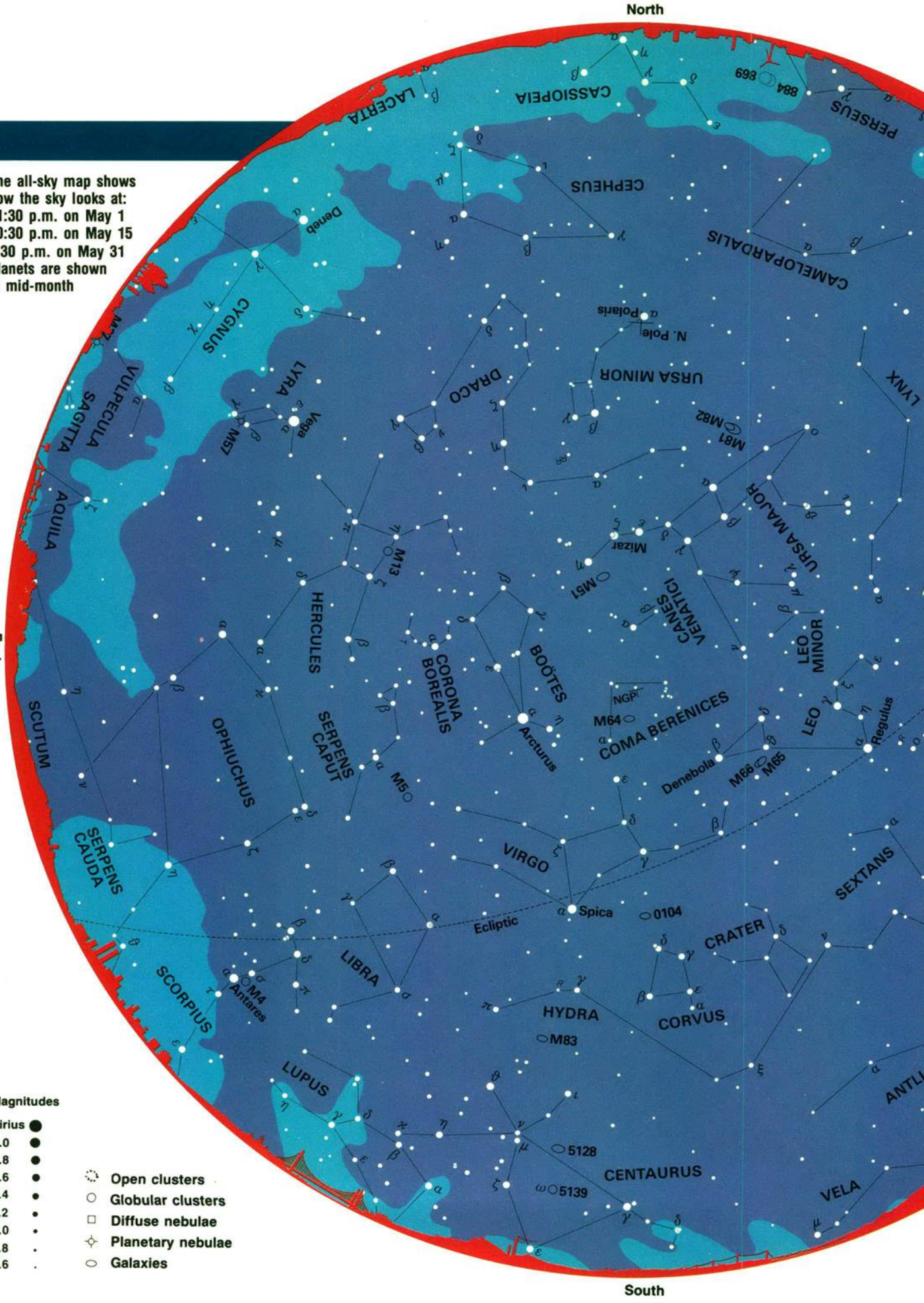
For .965" Eyepieces
#5558 **$24.95** (1.79)

For 1.25" Eyepieces #5560 **$24.95** (1.79)

- California residents add 6% sales tax (Santa Clara County 7%).
- Shipping and handling charges for UPS Ground or U.S. Mail are listed in (parentheses) after each price.
- 100% Money-Back Guarantee

ORION TELESCOPE CENTER

The all-sky map shows how the sky looks at:
11:30 p.m. on May 1
10:30 p.m. on May 15
9:30 p.m. on May 31
Planets are shown at mid-month



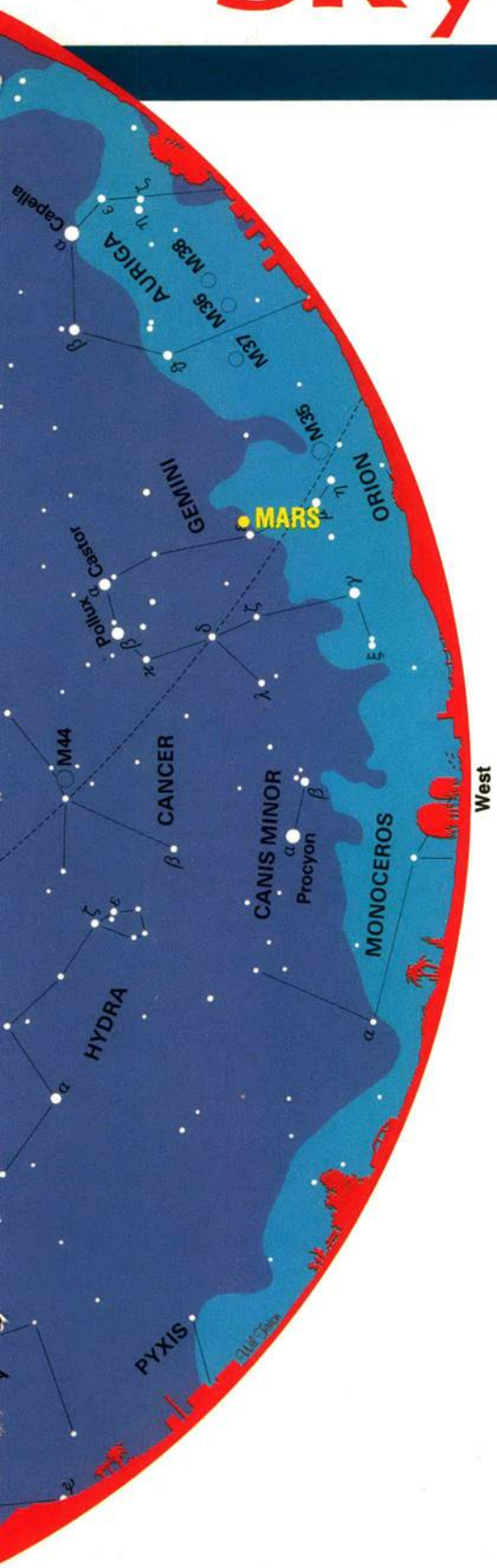
Magnitudes

- Sirius
- 0.0
- 0.8
- 1.6
- 2.4
- 3.2
- 4.0
- 4.8
- 5.6

- Open clusters
- Globular clusters
- Diffuse nebulae
- Planetary nebulae
- Galaxies

Sky Almanac

MAY 1989



MERCURY REMAINS BRIGHT

Mercury's best apparition of 1989 continues into the first ten days of May. Look for the elusive planet low in the west-northwest about forty-five minutes after sunset.

PLUTO AT ITS BEST

The planet Pluto is easier to see this month than at any time since its discovery in 1930. Nevertheless, Pluto remains by far the most difficult planet to observe, and you'll need at least an 8-inch telescope and excellent conditions to catch a glimpse of it.

1989'S BEST METEOR SHOWER?

The Eta Aquarid meteor shower should rival or exceed its more famous cousins this year, because the Moon is out of the sky. Expect to see between ten and forty meteors an hour in the predawn hours of May 4 to 6.

Dates and Times

3 Amphitrite is at opposition

4 The Moon is at perigee (223,560 miles from Earth)
Pluto is at opposition
Jupiter passes 5° north of Aldebaran, 1 p.m. EDT

5 Eta Aquarid meteor shower is at its best before dawn
New Moon is at 7:46 a.m. EDT

6 The Moon passes 3° north of Mercury, 6 p.m. EDT

7 The Moon passes 5° north of Jupiter, 3 a.m. EDT

8 The Moon passes 3° north of Mars, 9 p.m. EDT

12 First Quarter Moon is at 10:19 a.m. EDT
Mercury is stationary
The Moon passes 0.4° north of Juno, 11 p.m. EDT

13 The Moon passes 0.4° south of Regulus, 2 a.m. EDT

16 Mercury passes 0.6° north of Venus, 3 a.m. EDT
The Moon is at apogee (251,882 miles from Earth)

20 Full Moon is at 2:16 p.m. EDT

21 The Moon passes 0.4° south of Antares, 9 a.m. EDT

23 Venus passes 0.8° north of Jupiter, midnight EDT
Mercury is in inferior conjunction

24 The Moon passes 4° south of Saturn, midnight EDT

28 Last Quarter Moon is at 12:01 a.m. EDT

MERCURY'S BEST EVENING APPARITION

The innermost planet Mercury begins May at the height of its best apparition of the year. It may be seen in the west-northwest after sunset on any of the first ten evenings of May, provided you have clear skies and an unobstructed horizon.

There are many bright stars in this region of the sky, but you can locate Mercury by looking below and to the right of a conspicuously bright object, the planet Jupiter. The two planets form a lopsided triangle with the star Aldebaran, which is to their left, in the evening twilight. Mercury is brighter than Aldebaran for the first few days of the month, but afterward the star is brighter than the planet. On the evening of May 6 the waxing crescent Moon lies about halfway between Mercury and Jupiter and makes a nice grouping with the other objects.

Mercury lies 21° from the Sun on the night of April 30/May 1 when it shines brightly at magnitude 0.3. By May 10, Mercury has faded considerably, to magnitude 2.0, and by the middle of the month it has dimmed so much and sunk so deeply into the twilight glare that it is no longer visible to the unaided eye.

ETA AQUARID METEORS REACH PEAK

What may be the best meteor shower of 1989 peaks on the night of May 4/5. The Eta Aquarid shower produces ten to forty meteors per hour from a dark-sky site. Although this rate is not as high as some of the more famous meteor showers, the Perseids of August have been declining recently and this year's Orionids, Leonids, and Geminids are all drowned out by bright moonlight. That makes 1989 a good year to introduce or reacquaint yourself with this shower.

The Eta Aquarids should appear best in the hour or two before dawn on the morning of May 5. If weather prospects look poor for the 5th, the shower should still be good in the predawn hours of May 4 and 6. Choose an observing site far from city lights and take along a lawn chair or blanket to lie on. Look for the Eta Aquarids to streak rapidly across the sky and to leave glowing trails, two of the major characteristics of this shower. The meteors radiate from near the "Water Jar" asterism in the constellation Aquarius, which lies in the southeast before dawn.

THE RETURN OF VENUS

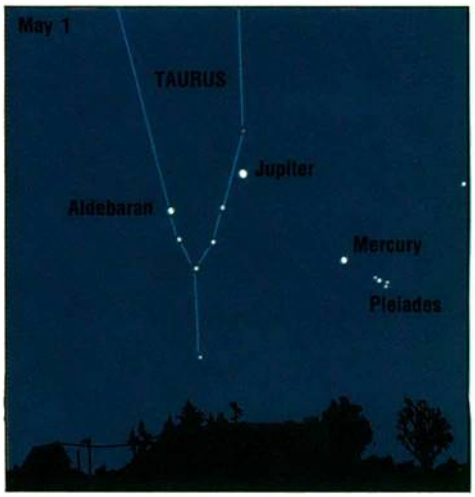
After three months lost from view on the far side of the Sun, Venus returns to naked-eye visibility in mid-May. On the evening of May 22, just after sunset, look for Venus poised less than a degree north of Jupiter. Venus will almost certainly be visible if the sky is clear and you have a low horizon. Binoculars may help you see the two planets together in the bright twilight. Although these are the two brightest planets, they are difficult to see now because they lie so near the Sun.

By the end of the month Venus can be seen easily as a shining beacon low on the west-northwestern horizon. No object in our sky, with the exception of the Sun and Moon, can match its brilliance. Even though it is on the other side of the solar system from us this month, Venus still shines at magnitude −3.9.

MAY'S PLANETS

Mercury has a reputation for being hard to see, but it is really quite easy if you know when and where to look. You can find the planet low in the west-northwest, below and to the right of much

MERCURY'S FINEST APPEARANCE of 1989 continues in the west-northwest on evenings in early May. Look for the planet near Jupiter forty-five minutes after sunset during the first ten days of May.

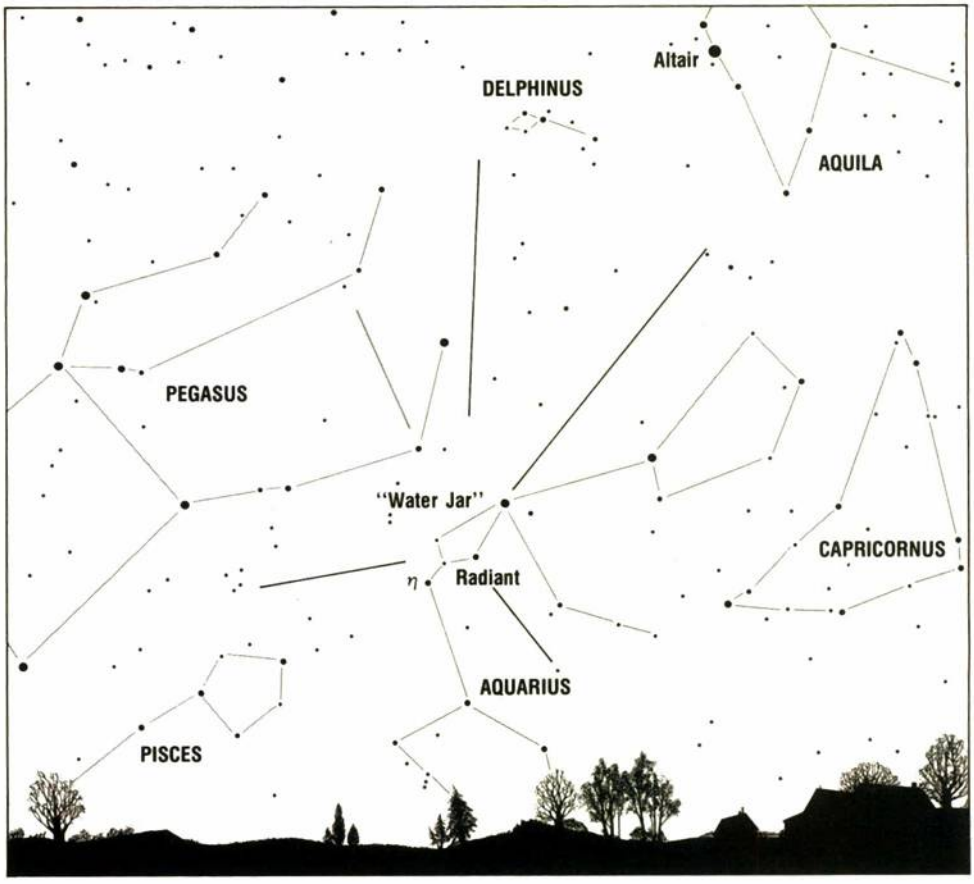


brighter Jupiter, during the first week and a half of May.

Mercury's reputation stems from its swift motion in our sky, a consequence of its closeness to the Sun. It moves at nearly 30 miles per second in its orbit, in contrast to 19 miles per second for Earth. This fast motion causes Mercury to come and go in our sky very quickly.

Mercury shines brightly when May begins but fades rapidly as the days pass. There are two reasons Mercury appears dimmer as the month progresses. First, Mercury sinks closer to the twilight each day and so the background against which it's seen grows brighter. Also, the planet is about to pass between the Sun and Earth, and its sunlit hemisphere is now turning away from us.

After dominating the evening sky for many months, Jupiter is still easy to see in early May low in the west-northwest after sunset. It shines at magnitude −2.0 among the many bright "winter" stars that are now disappearing from view. Jupiter still appears in the constellation Taurus and it passes 5° north of Aldebaran, the "Bull's eye," on May 4.



THE BEST METEOR SHOWER of 1989 may well be the Eta Aquarid shower, at its best in the predawn hours of May 5. Look for meteors coming from near the "Water Jar" asterism in Aquarius.

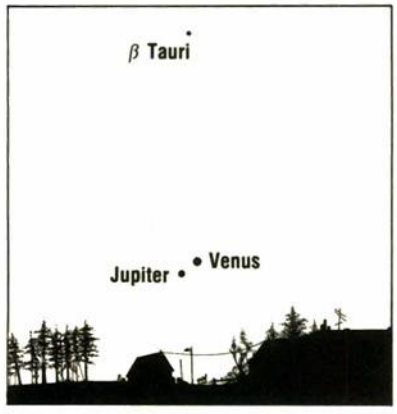
Jupiter lies about 8° from Mercury as the month begins. Unlike Mercury, which is now coming between us and the Sun, Jupiter is far across the solar system. Both planets are sinking into the twilight, and they edge a little closer to each other before they disappear.

Mercury drops into the sunset glare first. Jupiter lingers for some days after the middle of May but is gone entirely by the month's end. Its disappearance heralds the return of the brightest planet of them all, Venus.

Venus has been gone from the evening sky since this time last year, when it was sinking toward the Sun in the west on its way to passing between the Sun and Earth. It spent the rest of 1988 and the first part of 1989 in the morning sky and then disappeared behind the Sun for several months.

This month Venus returns to our evening sky. Look for the brilliant planet in late May, low in the west-northwest about half an hour after sunset. This is just the beginning of a long evening run for Venus: the planet gets higher and brighter during the summer and fall and remains visible through the end of the year.

VENUS REAPPEARS in the evening sky, low in the west-northwest, late in May. The solar system's brightest planet lies less than a degree from Jupiter about half an hour after sunset on May 22.



The Red Planet Mars lingers in the west-northwest after sunset. This month it sets about three-and-a-half hours later than the Sun.

Mars is falling behind us now in its orbit around the Sun. Unlike Jupiter, which has been sinking steadily into the twilight glow over the past several months, Mars has been moving swiftly toward the east among the stars. This eastward motion will keep it from dropping into the Sun's glare until early August.

The planet is now located in the constellation Gemini. Although it is rather inconspicuous at magnitude 1.7, its motion is very noticeable with respect to Gemini's two brightest stars, Castor and Pollux. Mars edges closer to these stars during May and will slide past them on the dome of our sky next month.

The next few months are the best time this year to watch the

golden-colored planet Saturn. Soon we will pass between Saturn and the Sun, and the planet will appear opposite the Sun in our sky. This is where the term "opposition" comes from, and it is at this time that any outer planet appears brightest.

This year's opposition for Saturn will occur in early July. In May the planet rises in the late evening and by the end of the month it comes up in the east-southeast only about an hour after the end of evening twilight.

Saturn is located above the "Teapot" asterism in the constellation Sagittarius, and it executes a rather low arc through the southern sky each night. Because the distance between Earth and Saturn is now decreasing, the planet is growing brighter in our sky. This month its brightness increases from magnitude 0.4 to 0.2.

MAY'S STARRY SKY

In early May the planet Saturn rises over the southeastern horizon in late evening, signaling the return of the richest part of the Milky Way Galaxy to our evening sky. Saturn is now located in approximately the same direction as the center of the Milky Way.

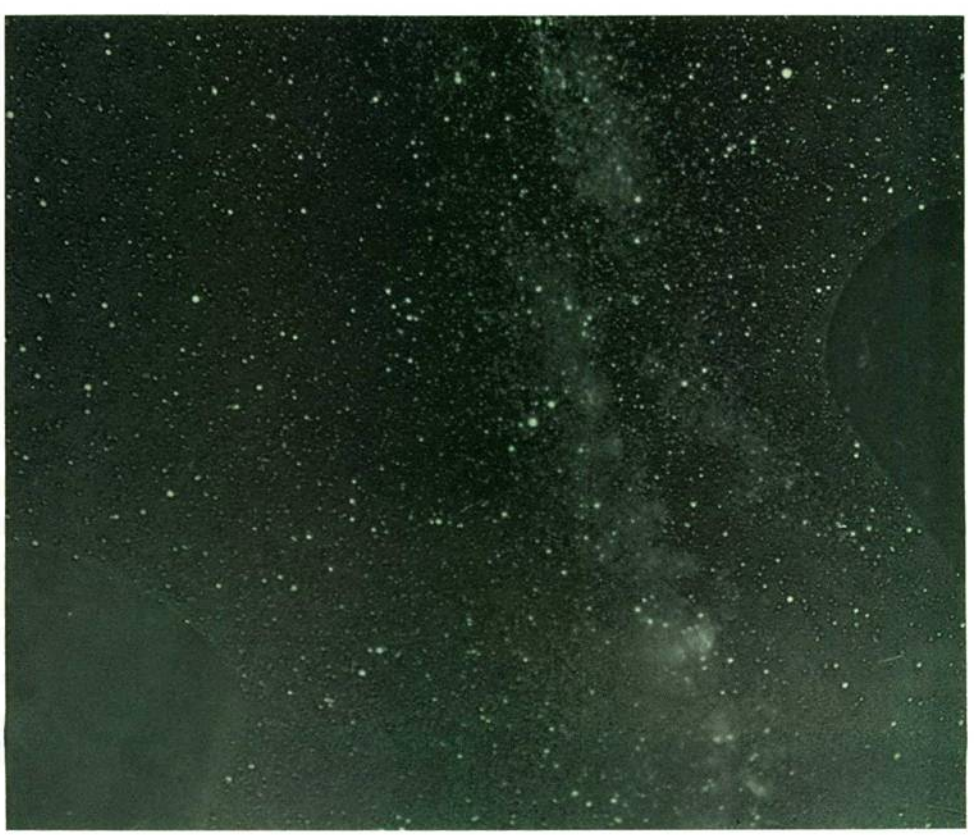
Under dark skies on late summer evenings the Milky Way appears as a hazy, starlit trail arcing across the sky. When we look into this arch of stars, we are looking into the disk of our own Galaxy, the flattened part that contains our Sun and most of the Galaxy's other stars. Our Sun revolves around the center of the Galaxy about two thirds of the way from the center to the Galaxy's outer edge.

Our location in the Galaxy explains why the character of the evening sky changes with the seasons. In summer we're looking generally toward the densely packed center of the Galaxy, and the sky is crowded with myriad faraway stars. In winter we're looking toward the outer edge of the Galaxy. This part is less densely packed with stars, and we see many bright, relatively nearby members of the spiral arm our Sun is in.

This month, however, the disk of our Galaxy cannot be seen from most of the United States until late evening. It lies nearly flat around the horizon for observers at low- and mid-northern latitudes in the early evening. That makes this month a good time to try to visualize where you are in the Galaxy.

Look straight up in the evening this month, and you are looking perpendicular to the disk of the Galaxy. The north galactic pole — located in the constellation Coma Berenices — is roughly overhead at 10 p.m. At that same time the disk of the Milky Way Galaxy is largely hidden in the haze around the horizon. (The map that opens the Sky Almanac section shows the starlit trail of the Milky Way draped around the horizon on May evenings.)

Then the Galaxy's center (and the planet Saturn) are just below the horizon to the southeast. The nearest edge of the Galaxy is in the opposite direction, toward the northwest. If you go outside and try to imagine it, you can sense your place in the Galaxy of stars that we call home. □



THE MILKY WAY arches high overhead on late summer evenings, in marked contrast to its current position around the horizon for Northern Hemisphere observers. Photo by Mace Hooley.

Through the Eyepiece by Rick Shaffer

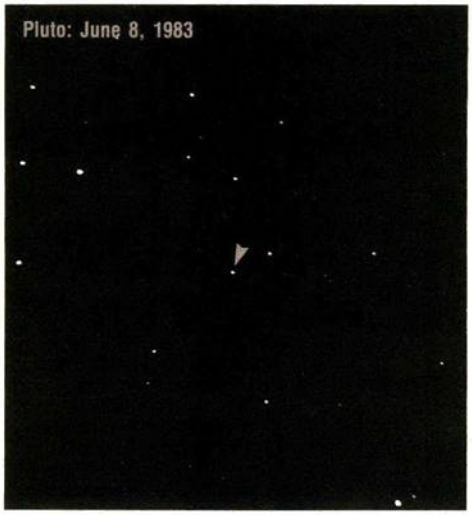
PLUTO AT OPPOSITION

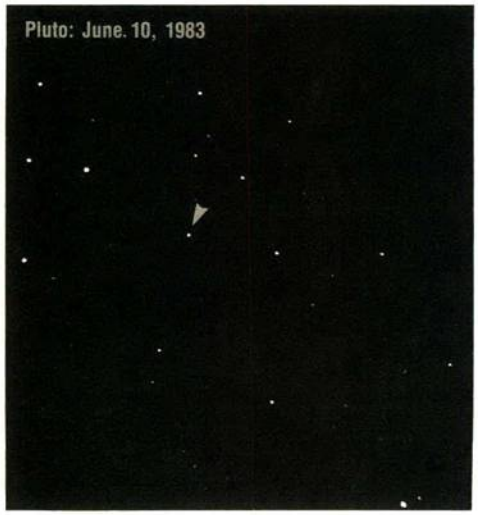
Pluto reaches opposition on the night of May 3/4. Although this normally would not be an important observational event, this year is different. Pluto reaches perihelion — its closest approach to the Sun in its 248-year orbital period — in early September, so this opposition occurs when Pluto is about as close to Earth and as bright as it ever gets. That makes this spring and summer the best time to view Pluto since its discovery fifty-nine years ago. (See "Get Ready for Pluto at Its Best" by Richard L. Talcott on page 84.)

To spot Pluto, you'll need an 8-inch or larger telescope because, despite being relatively close to Earth, the planet still shines dimly at magnitude 13.6. Select both an observing site known for good seeing and a night on which the seeing is good. (If the seeing is only average, it's better to wait for another night.) Choose an eyepiece that gives you about 15x to 20x per inch of aperture. With the finder chart on page 85, locate the starfield where Pluto lies that night. As you look through the eyepiece, you should see more stars than are shown on the finder chart. One of those points of light is Pluto, but which one?

To determine which "star" is Pluto, you must photograph or make an accurate drawing of the starfield and then repeat the process a few nights later. When you compare the two charts, the "star" that has moved is Pluto. (You can simplify the process if you have access to a copier that can enlarge images. Make successive copies of the finder chart until the field of view in your eyepiece is about three inches in diameter on the copy. Then circle the eyepiece field and make two copies of that enlargement. Use one as a template for your drawing on the first night and the other on the second night and compare the two to find out which star moved.)

As you gaze at Pluto, remember that Clyde Tombaugh spent hundreds of hours at Lowell Observatory exposing pairs of photographic plates, followed by more hundreds of hours "blinking" the pairs against one another, before he discovered Pluto. You, on the other hand, should be able to "discover" this most elusive planet in two nights with just a couple hours of observing.





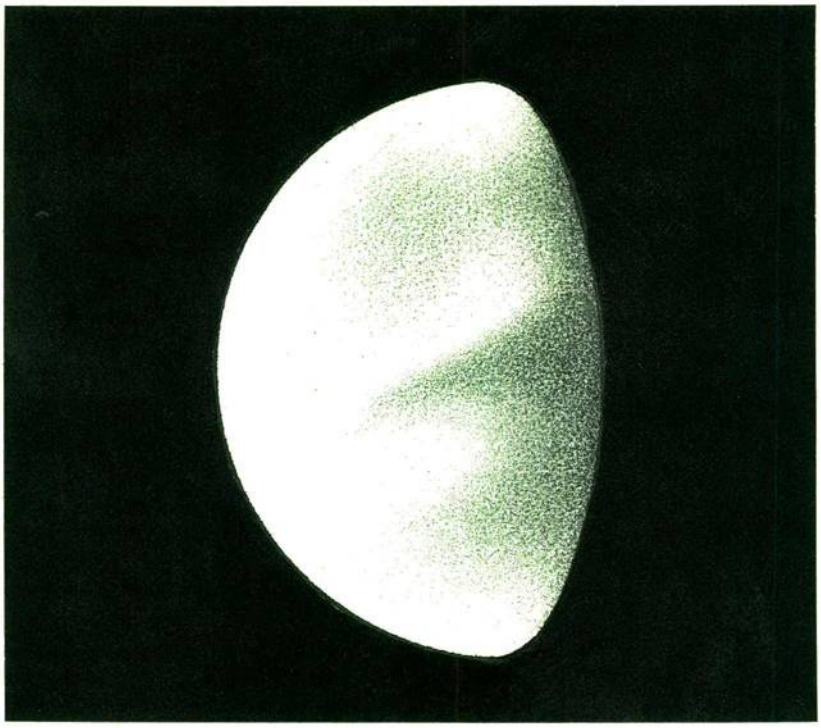
PLUTO IS AT ITS BRIGHTEST this May in southeast Virgo. The 14th-magnitude object can be found by tracking its motion visually or photographically over several days with an 8-inch or larger telescope. Photos by Paul Roques.

MERCURY'S SHRINKING CRESCENT

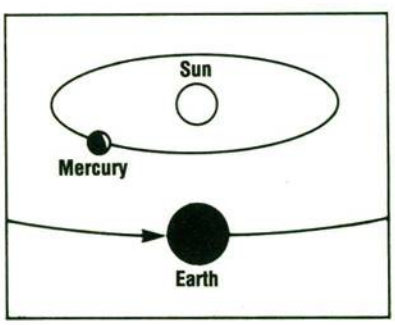
Although Mercury is often overlooked, it is a fine sight in telescopes during the first half of May. The Sun's closest and swiftest planet reaches greatest eastern elongation on the night of April 30/May 1. When Mercury reaches the lofty separation of 21° east of the Sun that night, it has almost the same azimuth as the Sun does at sunset for observers in mid-northern latitudes. This means that at sunset Mercury appears nearly as far above the horizon as it is east of the Sun, which makes this Mercury's best apparition of 1989.

To observe Mercury, you must pick a site with a clear horizon toward the west-northwest. Also, try to pick a site that is free of heat sources, such as buildings or asphalt parking lots. A grassy meadow, a park, the top of a hill overlooking a forest, or a west-facing beach are all good places from which to observe Mercury.

If you began observing Mercury in April, you know its phase went from gibbous in mid-April to half phase around April 26. On May 1, Mercury's phase is like that of a 5- to 6-day-old Moon. On that evening



MERCURY'S FINEST APPEARANCE of 1989 continues in the west-northwest on evenings in early May. Look for the planet near Jupiter forty-five minutes after sunset during the first ten days of May.



Mercury's disk is 8″ in diameter and it shines at magnitude 0.3. By the time Mercury sinks into the solar glare at mid-month, its disk is a very slender crescent 11″ in diameter and its magnitude has diminished to 3.0. The rapid changes in phase and magnitude warrant your paying Mercury nightly attention when the weather permits.

Because this is Mercury's best apparition of the year, it might be a good time to try to detect features on Mercury's surface. You should be aware, however, that these features are difficult to observe even in good seeing conditions. What might you see in an 8-inch or larger telescope? Modern ground-based observers have seen considerable limb darkening caused by light striking the rugged terrain at a grazing angle and subsequently being scattered. Other observers have seen large areas that are slightly darker than the average brightness of the disk. These are challenging observations to make, and you should count yourself lucky if you see anything other than the phases.

When you view Mercury, be sure to set up your telescope as the Sun is setting, because there is little time for that after the Sun has set. First, note the azimuth of the Sun as it sets. You can locate Mercury about half an hour after sunset by sweeping the sky with your finder scope or binoculars just 15° above and to the right (or north) of the Sun's setting azimuth. Remember, the long part of your closed fist held at arm's length spans approximately 10°, so Mercury should be one-and-a-half fists above the horizon approximately thirty minutes after sunset. Also, you can use the 7° field of typical 7x50 binoculars to estimate Mercury's elevation.

On May 6 at 22 UT the Moon passes 3° north of Mercury; nine hours later the Moon passes 5° north of Jupiter. North American observers can observe Mercury, Jupiter, and the Moon just about halfway between these two events. If weather permits, try to compare your impressions of the average surface brightnesses of the three objects by switching from one to the other to the third while using the same power eyepiece. The Moon and Mercury both reflect about 10 percent of the sunlight hitting them, while Jupiter reflects 52 percent. However, Jupiter is much farther from both the Sun and Earth than the other two are, so despite being the most reflective, it also has the dimmest surface.

TELESCOPIC PLANETS

In the middle of May Venus returns to the evening sky, where it meets sinking Mercury on the evening of the 15th. Mercury passes 0.6° north of Venus a few hours after sunset for North American observers, and the two planets appear in the same low-power field of view. This event occurs when the two planets are only 11° from the Sun, so selecting a good site to view it from is essential. You might even want to find Venus by offsetting from the Sun's position as I described in February's column. That way you can begin viewing Venus, at magnitude −3.9, before the Sun sets, although 3.4-magnitude Mercury probably will not be visible until after sunset. On the 15th the Sun's position is right ascension 3h31.3m and declination +19°04′, Mercury's is 4h17.4m and +22°06′, and Venus' is 4h15.9m and +21°24′.

If you begin observing before sunset, make sure not to point your telescope, finder, or binoculars at the Sun. And if you scan the sky with

your naked eye before sunset, block the Sun with your hand or some other object, otherwise you'll have to observe Mercury and Venus with spots before your eyes. Also consider making an extension to your dew cap or telescope tube out of black construction paper. If you have an extension tube, line it with black felt or flock paper. This will reduce the Sun's glare and make your observations much easier.

Mars doesn't have a lot going for it this month. It is so far from Earth that its disk subtends only 4.3″ on May 15. On a night of excellent seeing you might see the planet's polar cap but not much else.

Just after sunset on May 22, Venus joins yet another planet in a single low-power eyepiece field. Jupiter is Venus' companion this time, and the two are located just 0.8° apart that evening. Because Venus shines at magnitude −3.9 and Jupiter at −1.9 and because they are 13° from the Sun, you should have little trouble locating the pair. Just note the azimuth of the Sun at sunset and scan the sky a bit above that point half an hour later. Jupiter's 33″-diameter disk dwarfs the 10″ diameter of Venus' disk, even though Jupiter is nearly four times as far away. The reason is that Jupiter is physically eleven times larger than Venus.

Saturn is just two months away from its July 2 opposition and is a fine sight in any size telescope. The ringed planet is still in the morning sky, where it remains the only bright planet, but it now rises before midnight and is visible to those who like to stay up late. Still, the planet is better seen in the morning because it reaches its maximum elevation around the beginning of twilight.

Saturn brightens slightly in May, from magnitude 0.4 to 0.2, and grows noticeably larger in your eyepiece. The disk of the golden-colored planet measures 17.3″ across on May 1 and 18.0″ across on May 31, while the rings span 39.3″ on the 1st and 40.9″ on the 31st.

The two most distant gas giant planets, Uranus and Neptune, remain near Saturn this month, and they also rise before midnight and transit near the beginning of morning twilight. Uranus sports a 3.8″-diameter, blue-green disk and shines at magnitude 5.6. Its color and size make it unmistakable in a telescope's eyepiece. Neptune's bluish grey disk is smaller and fainter than that of Uranus, measuring just 2.3″ across and shining at magnitude 7.9.

ASTEROIDS IN THE EYEPIECE

The brightest asteroid to reach opposition this month is 9.6-magnitude 29 Amphitrite. It crosses from Libra into Virgo this month and may be found using the coordinates at upper right. Asteroid 10 Hygiea, which doesn't reach opposition until early June, is even brighter than Amphitrite, however. Hygiea is a 9th-magnitude object in Ophiuchus this month and crosses briefly into Scorpius in June. The finder chart and table of coordinates at right will help you locate Hygiea, but you'll have to monitor the asteroid's changing position over successive nights to confirm its identity.

The brightest of all the asteroids, Vesta, brightens from 7th to 6th magnitude in northern Sagittarius this month. It is on its way to a very favorable opposition late in June, when it will be barely visible to the naked eye. □

COORDINATES FOR AMPHITRITE

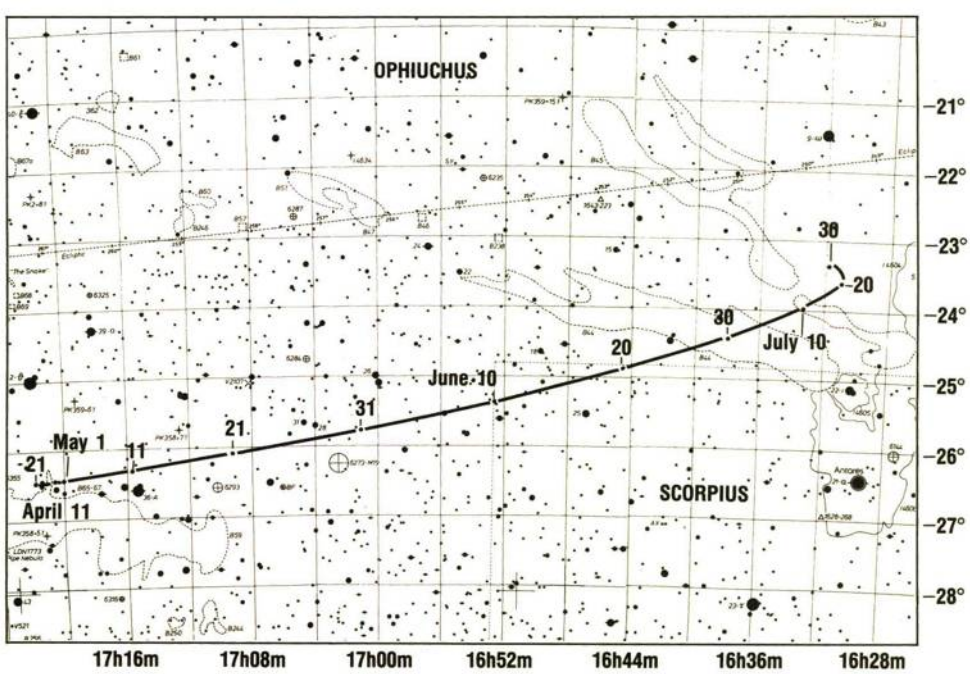
Date	R.A. (2000)	Dec.
April 11	14h55.2m	−23°11′
April 21	14h46.6m	−23°02′
May 1	14h36.9m	−22°40′
May 11	14h27.1m	−22°09′
May 21	14h18.3m	−21°32′
May 31	14h11.3m	−20°57′
June 10	14h06.8m	−20°27′
June 20	14h05.0m	−20°06′
June 30	14h05.7m	−19°56′

The positions of asteroid 29 Amphitrite are given for 0 UT.

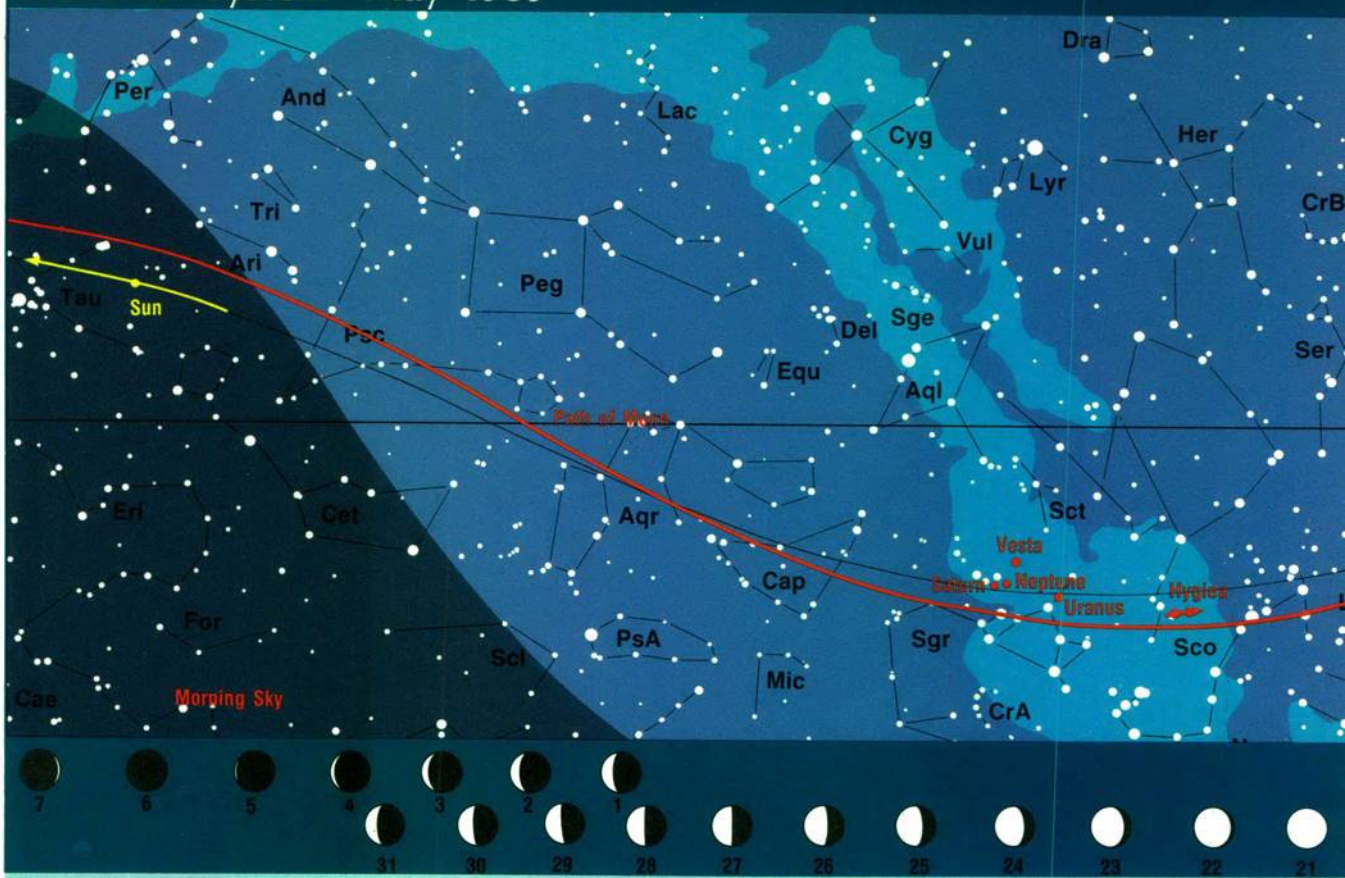
COORDINATES FOR HYGIEA

Date	R.A. (2000)	Dec.
April 11	17h20.6m	−26°25′
April 21	17h21.7m	−26°27′
May 1	17h20.0m	−26°25′
May 11	17h15.7m	−26°18′
May 21	17h09.2m	−26°05′
May 31	17h01.2m	−25°45′
June 10	16h52.6m	−25°21′
June 20	16h44.6m	−24°52′
June 30	16h38.0m	−24°23′
July 10	16h33.4m	−23°57′
July 20	16h31.3m	−23°35′
July 30	16h31.8m	−23°20′

FOLLOW ASTEROID 10 HYGIEA as it moves through Ophiuchus and Scorpius in the next three months. (Positions are given for 0 UT.)

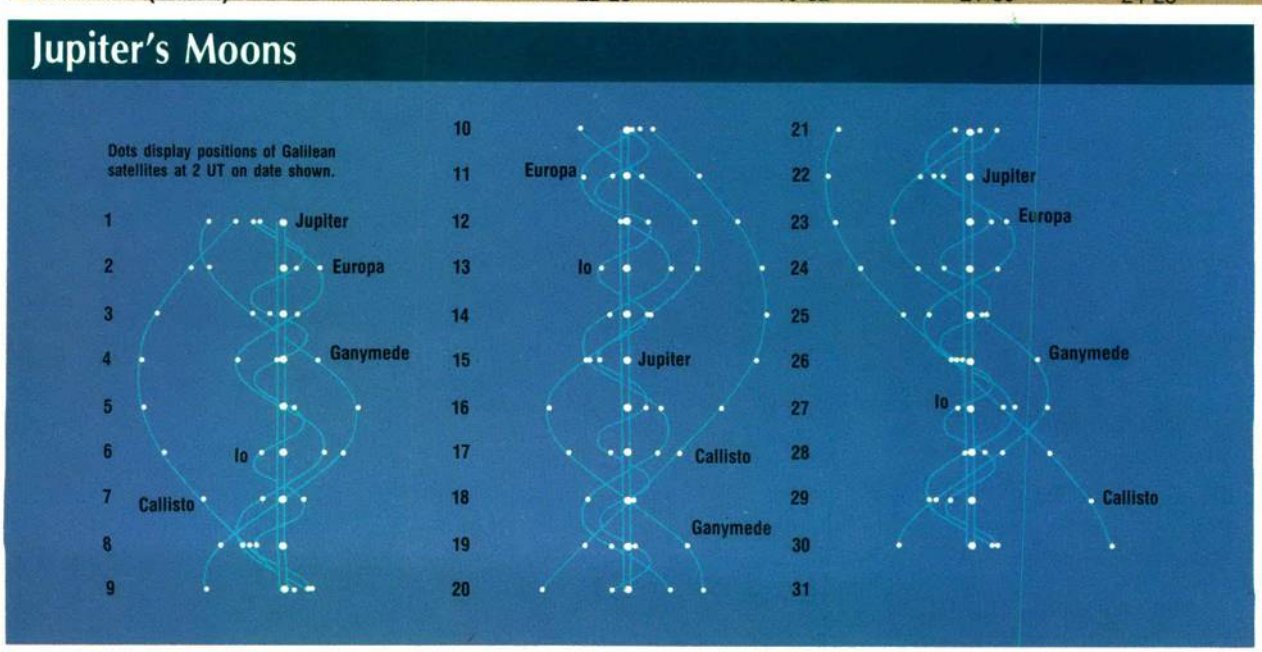


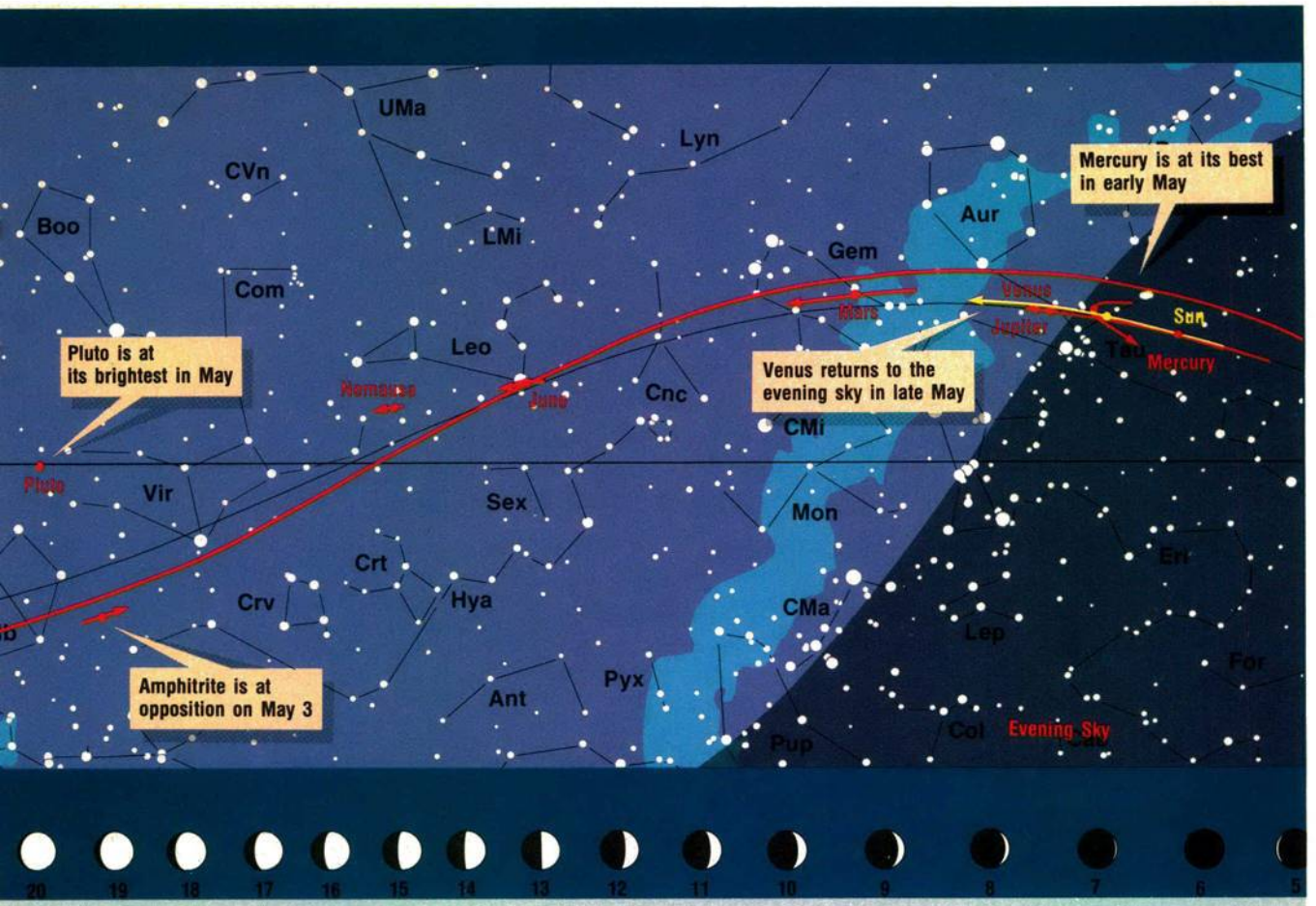
The Solar System May 1989



Planet	MERCURY	MERCURY	MERCURY	VENUS	MARS
Date	May 1	May 15	May 31	May 15	May 15
Magnitude	+0.3	+3.0	+3.6	−3.9	+1.7
Angular Size	7.89″	11.10″	11.79″	9.9″	4.3″
Illumination	38%	7%	4%	98%	95%
Distance (AU) from Earth	0.853	0.606	0.570	1.691	2.182
Distance (AU) from Sun	0.368	0.439	0.466	0.720	1.643
Right Ascension (2000.0)	3h54.6m	4h18.9m	3h51.3m	4h11.1m	6h43.7m
Declination (2000.0)	23°04′	22°26′	16°52′	21°09′	24°25′

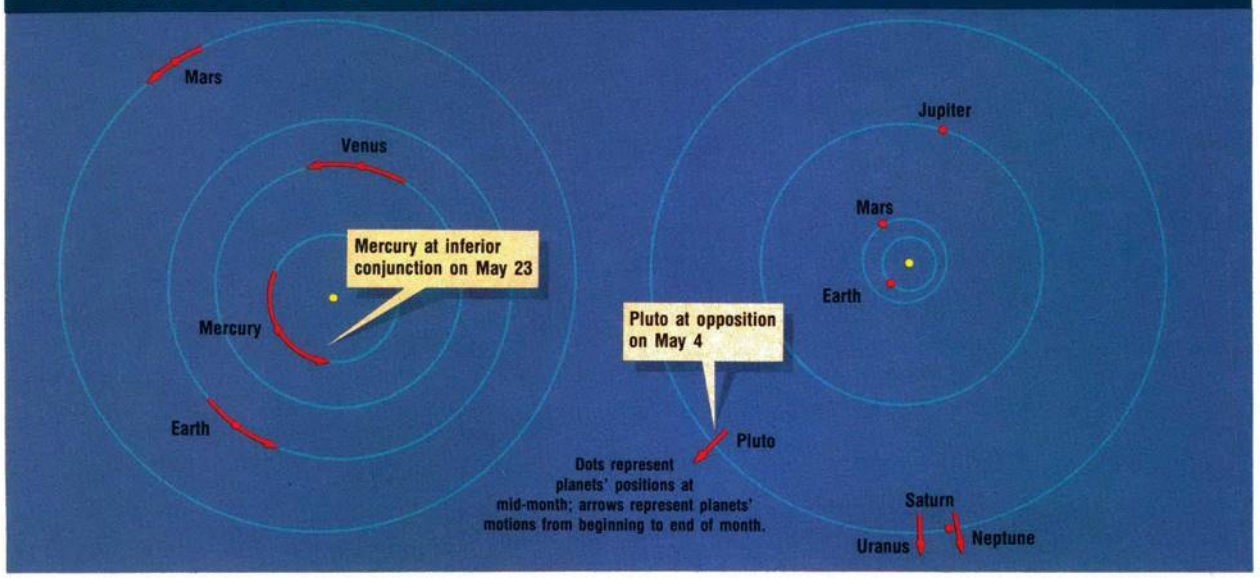
Jupiter's Moons





JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
May 15	May 15	May 15	May 15	May 15
−2.0	+0.3	+5.6	+7.9	+13.7
32.7″	17.7″	3.8″	2.3″	0.1″
100%	100%	100%	100%	100%
6.020	9.352	18.561	29.530	28.701
5.072	10.040	19.339	30.216	29.657
4h45.8m	18h59.2m	18h21.7m	18h53.0m	15h04.0m
21°54′	−22°05′	−23°36′	−21°57′	−0°20′

The Planets in Their Orbits



ALABAMA

Auburn — Auburn Astronomical Society. 1963 Canary Street, 36830. Rhonald M. Jenkins.
Birmingham — Birmingham Astronomical Society. 1425 22nd Street, 35205. Emmie Longshore, (205) 933-8422.
Huntsville — Von Braun Astronomical Society. Box 1142, 35807. (205) 539-0316.
Mobile — Mobile Astronomical Society. P.O. Box 9941, 36609. John Sledge, (205) 928-8893.
Rainbow City — Southside Astronomy Club. 103 Eddie Circle, 35901. Julian Long, (205) 442-7169.
Tuscumbia — Muscle Shoals Astronomical Society, Inc. 302 NE Commons, 35674. Homer Russell, Jr., (205) 383-6717.

ALASKA

Anchorage — Anchorage Astronomical Society. 3539 Dunkirk Drive, 99502. John Morrow, (907) 269-5744.
Fairbanks — Astronomical Units. Box 82210, 99708. Robert E. Fischer, (907) 456-6586.

ARIZONA

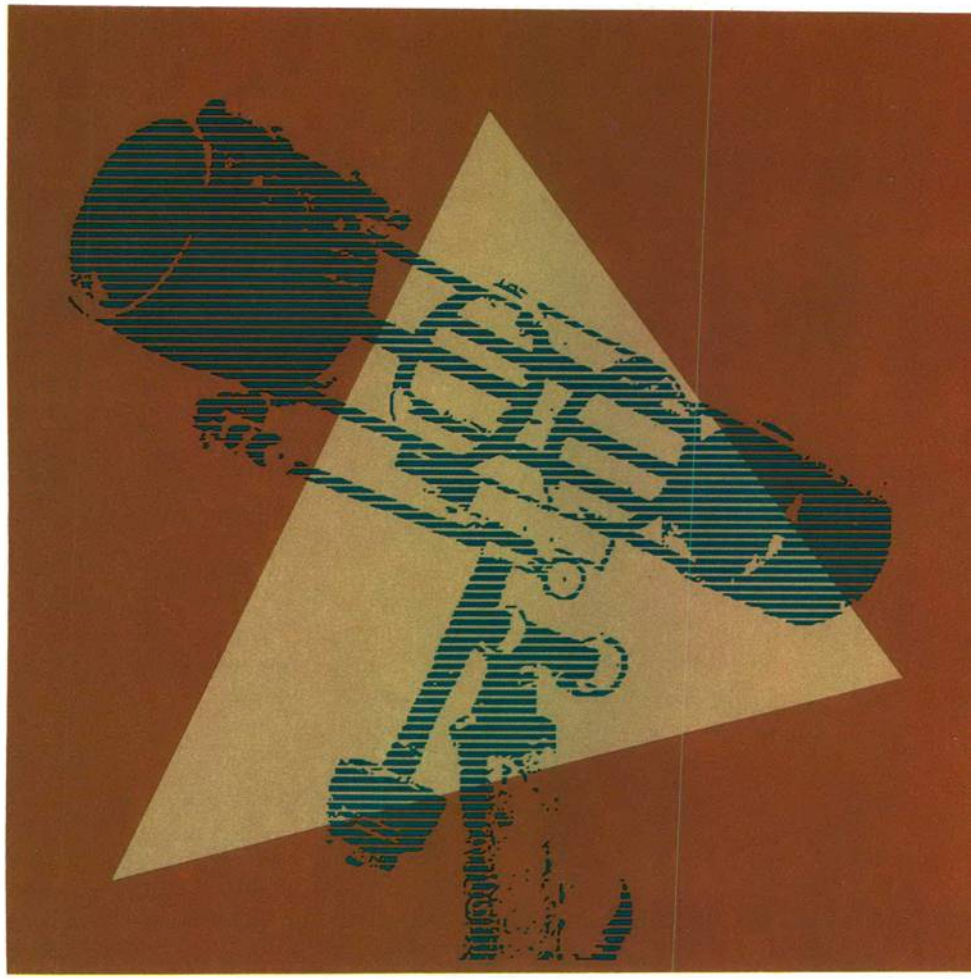
Mesa — Leisure World Astronomers. 1792 Leisure World, 85206. Bud Ridley, (602) 981-3136.
Scottsdale — Phoenix Astronomical Society. 6945 East Gary Road, 85254. Raul V. Espinoza, (602) 996-3617.
Scottsdale — Saguaro Astronomy Club. 11817 North 55th Street, 85254. Dan Ward, (602) 998-4033.
Tucson — Tucson Amateur Astronomy Association. 7222 East Brooks Drive, 85730. Terri Lappin, (602) 790-5053.

ARKANSAS

Arkadelphia — Ark-La-Tex Sky Watchers. 2302 Barkman Street, P.O. Box 493, 71923. Rex McDaniel, (501) 246-6575.
Fort Smith — Arkansas-Oklahoma Astronomical Society. P.O. Box 31, 72902. Larry Kennedy, (918) 436-2204.
Little Rock — Mid-South Astronomical Society. P.O. Box 5142, 72205. James (Bruce) McMath, (501) 376-3021.

CALIFORNIA

Berkeley — Sidewalk Astronomers. P.O. Box 10003, 94709. Gerald Pardeilhan, (415) 527-4026.
Cucamonga — Pomona Valley Amateur Astronomers. 8773 Balsa Street, 91730. Bob Hibble, (714) 989-3680.
Fresno — Central Valley Astronomers. 5790 East Tarpey Drive, 93727. Clarence Funk.
Hemet — Hemet Astronomical Society. 561 West Devonshire Avenue, 92343. Ralph L. Shook, (714) 658-3631.
Idyllwild — Idyll-Gazers Amateur Astronomy Club. P.O. Box 1245, 92349. Joe Neu, (714) 659-3562.
Lancaster — Antelope Valley Astronomical Society. P.O. Box 426, 93534. Steve Mathis, (805) 256-4261.
Los Angeles — Los Angeles Astronomical Society. 2800 East Observatory Road, 90027. Tom Dorff, (213) 926-4071.
Los Angeles — Problicom Sky Survey and Nova Patrol. 1940 Cotner Avenue, 90025. Ben Mayer, (213) 478-2524.
Moraga — Astronomical Association of Northern California. 731 Camino Ricardo, 94556. Don Stone, (415) 376-3007.
Mountain View — Peninsula Astronomical Society. P.O. Box 4542, 94040. Bill Sorrells, (415) 566-3116.
Newhall — "The Local Group" Astronomy Club of the Santa Clarita Valley. 25032 Walnut Street, 91321. LaVerne Booth, (805) 259-3284.
Oceanside — Oceanside Photo and Telescope Astronomical Society. 1024 Mission Avenue, 92054. Penny Hauck, (619) 723-0684.



Orange — Orange County Astronomers. 2215 Martha Avenue, 92667. John Sanford, (714) 639-8446.
Palm Desert — Astronomical Society of the Desert. College of the Desert, 43-500 Monterey Avenue, 92264. Ashley McDermott, (619) 346-8041 extension 273.
Pasadena — Asteroid Project. World Space Foundation, P.O. Box Y, 91030-1000. Jack Child, (818) 799-5135.
Pasadena — The Planetary Society. 65 North Catalina Avenue, 91106. Susan Lendroth, (818) 793-5100.
Riverside — Riverside Astronomical Society. P.O. Box 7213, 92505. Tom Fangrow, (714) 735-2068.
Rocklin — Sacramento Valley Astronomical Society. P.O. Box 575, 95677. R. S. Marasso, (916) 624-3333, extension 2291.
Salinas — Space Frontier Society of the Monterey Bay Area. P.O. Box 9382, 93915-9382. Oscar G. Garcia, (408) 757-2725.
San Bernardino — Valley Amateur Astronomers. 1345 Garner Avenue, 92411. David E. Garcia, (714) 884-0657.
San Diego — San Diego Astronomy Association. P.O. Box 23215, 92123. Greg Cade, (619) 560-1155.
San Diego — San Diego L5. P.O. Box 4636, 92104. Andrew Cutter, (619) 295-3690.
San Francisco — Association of Lunar and Planetary Observers. P.O. Box 16131, 94116. John Westfall, (415) 566-5786.
San Francisco — Astronomical Society of the Pacific. 390 Ashton Avenue, 94112. Berkeley Meeting Department, (415) 337-1100.
San Francisco — San Francisco Amateur Astronomers. Josephine D. Randall Museum, 114 Museum Way, 94114. Irving Hochman, (415) 641-0770.
San Jose — San Jose Astronomical Association. 3509 Calico Avenue, 95124. Jim Van Nuland, (408) 371-1307.
San Juan Bautista — Fremont Peak Observatory Association. Fremont Peak State Park, P.O. Box 1110, 95045. Denni Medlock, (415) 654-6796.
San Luis Obispo — Central Coast Astronomical Society. P.O. Box 1415, 93406. Lee Coombs, (805) 528-6682.
San Marcos — Astronomical Society of Southern California. P.O. Box 2046, 92069. Michael Wartenberg, (619) 741-6128.
Santa Barbara — Santa Barbara Astronomy Club. P.O. Box 3702, 93130. Clyde Kirkpatrick, (805) 685-2705.
Santa Cruz — Santa Cruz Astronomy Club. L-2 San Carlos Lane, 95065. James M. Bricken, (408) 335-2450.
Santa Monica — Santa Monica Amateur Astronomy Club. 1415 Michigan Avenue, 90404.
Santa Rosa — Sonoma County Amateur Astronomers. P.O. Box 183, 95402. Robert Ferguson, (707) 762-2064.
Simi Valley — Ventura County Astronomical Society. P.O. Box 982, 93062. Hal Jandorf, (805) 529-3984.
Tulare — Tulare Astronomical Association. P.O. Box 515, 93275-0515. Stanley H. Manro, (209) 686-6836.
Van Nuys — Los Angeles Valley College Astronomy Club. 5800 Fulton Avenue, 91401. Bruce Dale, (818) 781-1200 extension 335.
Walnut Creek — Mount Diablo Astronomical Society. 1725 Sunnyvale Avenue, 94596. Paul H. Cragey, (415) 676-6046.
Woodland Hills — Polaris Astronomical Society. 22018 Ybarra Road, 91364. (818) 705-9819.

COLORADO

Colorado Springs — Rocky Mountain Astrophysical Group. P.O. Box 25233, 80936. Paul B. Van Slyke, (719) 495-3828.
Denver — Denver Astronomical Society. P.O. Box 10814, 80210. Dave Trott, (303) 871-5172.
Longmont — Longmont Astronomical Society. P.O. Box 8086, 80501. Bob Spohn, (303) 772-1470.

ASTRONOMY

1989 Directory of Astronomy Clubs

Want to observe with fellow astronomers or talk shop? Need equipment advice? Observing tips? Contact one of the 300 astronomy clubs in our list and you'll discover how much fun amateur astronomers have when they get together.

CONNECTICUT

New Haven — Astronomical Society of New Haven, Inc. P.O. Box 3005, Westville Station, 06515. Edward C. Wetherbee, (203) 389-1198.

Oakdale — Thames Astronomical Society. 55 Doyle Road, 06370. Kathleen Audette, (203) 859-0071.

Stamford — Fairfield County Astronomical Society. 39 Scofieldtown Road, 06903. Charles Scovil, (203) 322-1648.

Waterbury — Mattatuck Astronomical Society. Mattatuck Community College, Math/Science Division, 750 Chase Parkway, 06708.

West Hartford — Astronomical Society of Greater Hartford. Gengras Planetarium, 950 Trout Brook Drive, 06119. Jay Sottolano, (203) 651-0096.

DELAWARE

Greenville — Delaware Astronomical Society. Mount Cuba Astronomical Observatory, P.O. Box 3915, Hillside Mill Road, 19807.

FLORIDA

Bradenton — Local Group of Deep-Sky Observers. 2311 23rd Avenue West, 34205. Vic and Lynne Menard, (813) 747-8334.

Fort Pierce — Treasure Coast Astronomical Society. 131 Queen Catherina Court, 34949. Walter Swentzell, (407) 465-4454.

Gainesville — Alachua Astronomy Club. 3426 SW 75th Street, 32607. Charles Tarjan, (904) 377-7403.

Key Biscayne — Southern Cross Astronomical Society, Inc. 690 Allendale Road, 33149. (305) 661-1375.

Orlando — Central Florida Astronomical Society. 810 East Rollins Street, 32803. Doug Monington, (407) 896-7151.

Panama City — Astronomy Club of Bay County. 425 East 19th Street # 106, 32405. Dick Suiter, (904) 785-0706.

Pensacola — Astronomical League. 6235 Omie Circle, 32504-7625. Merry Wooten, (904) 477-8859.

Pensacola — Escambia Amateur Astronomers' Association. 6235 Omie Circle, 32504-7625. Wayne Wooten, (904) 477-8859.

St. Augustine — Ancient City Astronomy Club, Inc. P.O. Box 546, 32085-0546. S. Whitford, (904) 269-2602.

St. Petersburg — St. Petersburg Astronomy Club, Inc. 594 59th Street South, 33707. Daniel W. Bricker, (813) 343-1594.

Tampa — MARS-Astronomy Club. 7407 Del Bonita Court #69, 33617. Emilio Toro, (813) 985-9289.

Tampa — Society of Amateur Radio Astronomers, Inc. P.O. Box 4208, 33677-4208.

West Palm Beach — Astronomical Society of the Palm Beaches, Inc. South Florida Science Museum, 4801 Dreher Trail North, 33405. Gary M. Bogner, (407) 832-1988.

GEORGIA

Athens — Athens Astronomical Association. 160 Plantation Drive, 30605. Maurice E. Snook, (404) 543-3753.

Augusta — Astronomy Club of Augusta. P.O. Box 6373, 30916. Jerry Barton, (404) 793-3420.

Macon — Middle Georgia Astronomical Society. Museum of Arts and Sciences, 4182 Forsyth Road, 31210. Gary L. Kretsinger, (912) 956-2145.

Savannah — Oglethorpe Astronomical Association. 4405 Paulsen Street, 31405. Vickie Psillos, (912) 355-6705.

HAWAII

Captain Cook — Mauna Kea Astronomical Society. 84-5095 Hawaii Belt Road, 96704. Howard Yamasaki, (808) 328-9201.

Honolulu — Hawaiian Astronomical Society. P.O. Box 17671, 96817. Kayoko Calef, (808) 531-4567.

Makawao, Maui — Maui Astronomy Club. 325 Olokani Street, 96768. Bob Bennett, (808) 572-1939.

ILLINOIS

Barrington — Northwest Suburban Astronomers. 4960 Chambers Drive, 60010. Bob Long, (312) 991-7432.

Batavia — Fox Valley Astronomical Society. P.O. Box 508, 60510.

Chicago — Chicago Astronomical Society. P.O. Box 48540, 60648.

Glenview — Space Science Explorer Post #998. 910 Glenwood Lane, 60025. Gretchen Trinklein, (312) 998-1627.

Joliet — Joliet Astronomical Society. P.O. Box 3893, 60435.

Libertyville — Lake County Astronomical Society. 603 Dawes Street, 60048. Jack Kramer, (312) 362-0959.

Lisle — Illinois Benedictine College Astronomical Society. 5700 College Road, 60532-2099. Robert S. Buday, (312) 960-1500.

Midlothian — Sunsearch. 14400 Kolin Avenue, 60445. Steve H. Lucas.

Naperville — Naperville Astronomical Association. 910 Fairway #203, 60540. Ray Bright, (312) 369-3533.

Normal — Twin City Astronomers, Inc. Illinois State University Planetarium, P.O. Box 755, 61761. Donald F. Johnson, (309) 452-3866.

Peoria — Peoria Astronomical Society, Inc. 1125 West Lake Avenue, 61614. Michael Hay, (309) 347-7285.

Quincy — Quincy Astronomical Society. #22 Summer Creek Drive, 62301-9808. Brad Haubrich, (217) 222-8832.

Rock Island — Popular Astronomy Club, Inc. John Deere Planetarium, Augustana College, 61201. Paul Castle, (309) 786-6119.

Rockford — Rockford Amateur Astronomers, Inc. 6804 Alvina Road, 61103. Barry or Carol Beaman, (815) 962-6540.

St. Charles — Argonne Astronomy Club. 6N106 White Oak Lane, 60175. H. F. DaBoll, (312) 584-1162.

Sugar Grove — Fox Valley Sky Watchers. Wauhonsee Community College, Route #47, 60118. Mike Anderer, (312) 377-6141.

Urbana — Astronomical Society at the University of Illinois. 349 Astronomy Building, 61801. Michael Svec.

INDIANA

Evansville — Evansville Astronomical Society. P.O. Box 3474, 47733. Jeff Bunner.

Fort Wayne — Fort Wayne Astronomical Society. P.O. Box 6004, 46896. Greg O' Neill.

Mooresville — Indiana Astronomical Society. 2 Wilson Drive, 46158. John P. May, (317) 831-3009.

Warsaw — Warsaw Astronomical Society. Rural Route #8, Box 236, 46580. Jim Tague, (219) 269-1856.

IOWA

Ames — Ames Area Amateur Astronomers. 1208 Wilson Avenue, 50010. David Oesper, (515) 232-8705.

Burlington — Southeastern Iowa Astronomy Club. 610 Walnut Street, 52601. Jim Blair, (319) 753-2509.

Cedar Rapids — Cedar Amateur Astronomers, Inc. 1513 Parkwood Lane NE, 52338. Frank Olsen, (319) 393-5758.

Des Moines — Des Moines Astronomical Society, Inc. 2307 49th Street, 50310-2538. Connie Allen.

Davenport — Quad Cities Astronomical Society. P.O. Box 3706, 52808. Dana Taylor, (319) 322-2557.

KANSAS

Topeka — Northeast Kansas Amateur Astronomers League. P.O. Box 951, 66601. Gary Hug, (913) 354-4479.

Wichita — Kansas Astronomical Observers. P.O. Box 49013, 67202-9013. Sara Sigwing, (316) 263-7091.

KENTUCKY

Louisville — Louisville Astronomical Society. Museum of History and Science, 727 West Main Street, 40402. Alan Goldstein, (502) 589-4584.

LOUISIANA

Abbeville — Astronomical Society of Acadiana. 805 South Guegnon, 70510. Dave Thomas, (318) 837-2871.

Baton Rouge — Baton Rouge Astronomical Society, Inc. 17324 Gains Mill Avenue, 70817. Mark Stauffer, (504) 273-2320.

Shreveport — Shreveport Astronomical Society, Inc. 1426 Alma Street, 71108. Jennie Goodwin, (318) 865-2433.

Westwego — Pontchartrain Astronomy Society, Inc. 948 Avenue "E", 70094. Michael D. Sandras, (504) 340-0256.

MAINE

Eliot — Astronomical Society of Northern New England. West Hill Observatory, 80 Goodwin Road, 03903. Ray Sutton, (207) 439-4474.

MARYLAND

Bel Air — Harford County Astronomical Society. P.O. Box 906, 21014. Gary McDaniel, (301) 838-1338.

Glen Burnie — Baltimore Astronomical Society. 305 Patsy Avenue, 21061. Jacki Zeun, (301) 766-6605.

Greenbelt — Goddard Astronomy Club. Goddard Space Flight Center, Code 440.8, 20771.

Hagerstown — Tristate Astronomers. Washington County Planetarium, 823 Commonwealth Avenue, 21740. Rodney L. Martin, (301) 791-4172.

Silver Spring — International Occultation Timing Association. P.O. Box 7488, 20901. David W. Dunham, (301) 495-9062.

Silver Spring — Nations Capital Astronomers. 202 Piping Rock Drive, 20904. G. R. Wright.

MASSACHUSETTS

Amherst — Amherst Area Amateur Astronomers Association. P.O. Box 335, 01059. Bernie Volz, (413) 253-5057.

Cambridge — American Association of Variable Star Observers. Birch Street, 02138. Janet Mattei, (617) 354-0484.

Dover — Amateur Telescope Makers of Boston. 8 Pond Street, 02030. Gary Walker, (508) 785-0352.

Harwich — Cape Cod Astronomical Society. P.O. Box 56, 02645. James C. Carlson, (508) 432-4316.

Watertown — Earthwatch. 680 Mount Auburn Street, Box 403N, 02272. Blue Magruder, (617) 926-8200.

West Springfield — Springfield Stars Club. 107 Lower Beverly Hills, 01089. John E. Welch, (413) 734-9179.

MICHIGAN

Bridgeport — Sunset Astronomical Society. 3622 Towerline, 48722. Timothy Jay Ross, (517) 777-2824.

Brighton — Friends United through Astronomy. 8191 Woodland Shore, Lot #12, 48116. Gary Anderson, (313) 227-9347.

Detroit — Detroit Astronomical Society. 14298 Lauder Avenue, 48219. (313) 837-0130.

East Detroit — Warren Astronomical Society. P.O. Box 474, 48021. Alan Rothenberg, (313) 344-2854.

East Lansing — Capital Area Astronomy Club. Abrams Planetarium, Michigan State University, 48824. David Batch, (517) 355-4676.

Grand Rapids — Astronomy Day/Astronomical League. Chaffee Planetarium, 54 Jefferson SE, 49503. Gary Tomlinson, (616) 456-3985.

Hillsdale — Astronomical Society of Hillsdale County. 5260 North Dunes Road, 49242. Pat Calligan, (517) 439-1295.

Kalamazoo — Kalamazoo Astronomical Society. Kalamazoo Public Museum Planetarium, 315 South Rose Street, 49007. Eric Schreur, (616) 345-7092.

Lowell — Grand Rapids Amateur Astronomical Association. James C. Veen Observatory, 3308 Kissing Rock Road SE, 49331. Evelyn Marron, (616) 897-7065.

Marquette — Marquette Astronomical Society. Shiras Planetarium, 1203 West Fair Avenue, 49885. John R. Shibley, (806) 225-1066.

Muskegon — Muskegon Astronomical Society. P.O. Box 363, 49443. Dale Johnson, (616) 798-7680.

Petersburg — Toledo Astronomical Association. 8534 Covert Road, 49270. Courtney J. Earhart, (313) 856-6204.

Plymouth — Astronomical Society of Michigan. 11422 Waverly, 48170. Michael Best, (313) 459-BEST.

Sturgis — Sturgis Astronomy Group. 302 Virginia, 49091. Philip Thrasher, (616) 651-8176.

MINNESOTA

Brainerd — North Star Astronomy Club. 1113 9th Avenue NE, 56401. Lonnie Converse, (218) 828-4589.

Duluth — Arrowhead Astronomical Society. Alworth Planetarium, University of Minnesota-Duluth, 55812. Glenn Langhorst, (218) 726-7129.

Moorhead — Moorhead-Fargo Astronomical Society. Department of Physics, Concordia College, 56560.

New Ulm — Minnesota Valley Amateur Astronomers. Route 4, Box 15A, 56073. Roger Dier, (507) 359-2488.

St. Paul — Minnesota Astronomical Society. 30 East 10th Street, 55101. Max Radloff, (612) 451-7680.

MISSISSIPPI

Jackson — Jackson Astronomical Association. 6207 Winthrop Circle, 39206. Walter Rebmann, Jr., (601) 982-2317.

MISSOURI

Blue Springs — Astronomical Society of Kansas City. P.O. Box 400, 64015. Vic Winter, (816) 432-3536.

Cape Fair — Ozarks Telescope Makers and Amateur Astronomers. P.O. Box 165, 65624. Gregory Blount, (417) 538-4553.

Florissant — McDonnell Douglas Amateur Astron-

SEE THE NEWEST in homemade telescopes at the Riverside Telescope Makers Conference in Big Bear, California.

THE OLDEST AND BIGGEST star party, Stellafane, draws two thousand people and their scopes to Springfield, Vermont.

omy Club. 3491 Heather Trail Drive, 63031. Richard Melvin, (314) 569-4773.

St. Peters — St. Louis Astronomical Society. 14055 Baywood Villages, 63017. Cecelia Brown, (314) 278-1191.

Winfield — Rural Astronomers of Missouri. Route 1, Box 501, 63389. John Sgouros, (314) 668-8574.

NEBRASKA

Lincoln — Prairie Astronomy Club. P.O. Box 80553, 68501. Lee Thomas, (402) 483-5639.

Omaha — Omaha Astronomical Society. 3390 South 130th Street, 68144. George Allen, (402) 333-1097.

NEVADA

Elko — Elko Nevada Astronomical Society. 550 South 12th #22, 89801. Len Seymour, (702) 738-7916.

Las Vegas — Las Vegas Astronomical Society. Clark County Community College Planetarium, 3200 East Cheyenne Avenue, 89030. John Ruff, (702) 459-8401.

Reno — Astronomical Society of Nevada. 825 Wilkinson Avenue, 89502. Italo Gavazzi, (702) 329-9946.

NEW HAMPSHIRE

Keene — Keene Amateur Astronomers, Inc. 12 Gardner Street, 03431. Philip N. Atwood, (603) 352-5058.

NEW JERSEY

Audubon Park — Small Scope Observers Association. 4 Kingfisher Place, 08106. Robert Browning, (609) 547-9487.

Clifton — North Jersey Astronomical Group. Rifle Camp Park Nature Center, P.O. Box 4021, Allwood Station, 07012. Phil Conroy, (201) 523-0024.

Cranford — Amateur Astronomers, Inc. Union College Sperry Observatory, 07016. Roger W. Tuthill, (201) 232-1786.

High Bridge — New Jersey Astronomical Association. Vorhees State Park, P.O. Box 214, 08829. Ben Cavotta, (215) 253-7294.

Lincroft — STAR Astronomy Society. Monmouth County Park System, Newman Springs Road, 07738. Doug Krampert, (201) 872-2670.

Merchantville — Willingboro Astronomical Society. P.O. Box 1457, 08109. Joy Crist, (609) 829-4345.

Princeton — Amateur Astronomers Association of Princeton. P.O. Box 2017, 08540. Art Esposito, (609) 737-2575.

Toms River — ASTRA. Novins Planetarium, Ocean County College, 08754-2001.

NEW MEXICO

Alamogordo — Alamogordo Amateur Astronomers. 1210 Filipino, 88310. Paula Hamilton, (505) 434-0115.

Albuquerque — Albuquerque Astronomical Society. P.O. Box 54072, 87153. Bruce L. Levin, (505) 299-0891.

NEW YORK

Bay Shore — Astronomical Society of Long Island, Inc. 1011 Howells Road, 11706. Jo-Ann Tompkins, (516) 586-1760.

Buffalo — Buffalo Astronomical Association, Inc. Buffalo Museum of Science, Humboldt Parkway, 14221. Doris Koestler, (716) 683-2970.

Corning — Elmira-Corning Astronomical Society. 17 West Hazel Street, 14830. Marilyn L. O'Connell, (607) 962-5435.

Frewsberg — Marshall Martz Memorial Astronomical Society. 176 Robin Hill Road, 14738. Gary Nelson, (716) 483-1955.

Geneva — Finger Lakes Astronomy Club. 42 Colt Street, 14456. Everett Jennings, (315) 781-0383.

Lindenhurst — Amateur Observers Society of New York. 707 South 9th Street, 11757. Eric Barnes, (516) 957-3713.

Lockport — Lockport Astronomy Association. 7053 Northview Drive, 14094. Richard Lahrs, (716) 433-4706.

New York — Amateur Astronomers Association of New York, Inc. 1010 Park Avenue, 10028. (212) 535-2922.

Pearl River — Rockland Astronomy Club. 110 Pascack Avenue, 10965. Allan Green, (914) 735-7303.

Saranac Lake — Tri-Lakes Astronomical Society. P.O. Box 806, 12985. Daniel Ferguson, (518) 891-0339.

Schenectady — Albany Area Amateur Astronomers. 1529 Valencia Road, 12309. Bob Mulford, (518) 374-8744.

Southold — Custer Institute. P.O. Box 1204, 11971. Charles Cardona, (516) 765-2626.

Staten Island — Astronomical Society of New York City. 153 Arlo Road, 10301. T. W. Hamilton, (718) 727-1967.

Syracuse — Syracuse Astronomical Society, Inc. 1115 East Colvin Street, 12310. Denise Sabatini, (315) 458-1454.

Vestal — Broome County Astronomical Society. Roberson-Kopernik Observatory, Underwood Road, 13850. Jay Sarton, (607) 772-0660.

Watertown — Northern New York Astronomical Society. P.O. Box 106, 13601. Pete Beaumont, (315) 788-2472.

NORTH CAROLINA

Asheville — Starfax Association. P.O. Box 6084, 28816. Timothy Jordan.

Castle Hayne — Cape Fear Astronomy Club. 110 Linville Drive, 28429. Paul Petty, (919) 675-2952.

Fayetteville — Astronomy Club of Cumberland County. 2308 Colgate Drive, 28304. Allen Faircloth, (919) 485-8515.

Gastonia — Gaston Astronomy Club. P.O. Box 953, 28054. Larry Benfield, (704) 825-5341.

Granite Falls — Catawba Valley Astronomy Club. 12 East Street, 28630. Greg Kirby, (704) 396-7656.

Raleigh — Raleigh Astronomy Club. P.O. Box 10643, 27605. (919) 832-NOVA.

Salisbury — Astronomical Society of Rowan County. Margaret Woodson Planetarium, 1636 Parkview Circle, 28144. Ellen Trexler, (704) 636-3462.

Shelby — Cleveland County Astronomy Society. 825 Ivywood Drive, 28150.

Trinity — Thomasville Area Astronomy Club. Route 3, Box 273, 27370. Arthur Oates, (919) 431-5062.

Winston-Salem — Forsyth Astronomical Society. 504 Gayron Drive, 27105. Stan Griffin, (919) 744-7141.

NORTH DAKOTA

Bismarck — Dakota Astronomical Society. P.O. Box 2539, 58502-2539. John R. Wetsch, (701) 256-3620.

OHIO

Akron — Astronomy Club of Akron, Inc. 1630 Thornapple Avenue, 44301. Mark Kochheiser, (216) 724-7761.

Chagrin Falls — Chagrin Valley Astronomical Society. P.O. Box 11, 44022. Don Himes, (216) 247-5114.

Columbus — Columbus Astronomical Society. P.O. Box 16209, 43216. Tom Burns, (614) 262-9713.

Dayton — Miami Valley Astronomical Society. 2629 Ridge Avenue, 45414. Wade E. Allen, (513) 275-7431.

Fostoria — Sandusky Valley Amateur Astronomy Club. 319 South Vine Street, 44830. Bill Davis, (419) 435-5953.

Lorain — Black River Astronomical Society. 1631 Maple Drive, 44052. Michael Harkey, (216) 288-8556.

Mansfield — Richland Astronomical Society. R.D. 10, Touby Road, 44903. Emil Diuner.

Parma — Cuyahoga Astronomical Association. P.O. Box 29089, 44129. Allan Jenks, (216) 237-4223.

OKLAHOMA

Boise City — Cimarron County Star Gazers. P.O. Box 278, 73933. Jim Rosebery, (405) 544-2222.

Enid — Northwest Oklahoma Astronomy Society. 1719 Pawnee, 73703. Dan Mathews, (405) 237-3562.

Lone Grove — Arbuckle Astronomical Society. Star Route, Box D-2, 73443. Jovita Black, (405) 657-8509.

Oklahoma City — Oklahoma City Astronomy Club. 2100 NE 52, 73111. Wayne Wyrick, (405) 424-5545.

Sallisaw — Sallisaw Amateur Telescope Club. 109 South Cedar, 74955. Bob Moody, (918) 775-3739.

Tulsa — Astronomy Club Of Tulsa. P.O. Box 740611, 74147-0611. Newell Pottorf, (918) 742-7577.

OREGON

Eugene — Eugene Astronomical Society. Lane ESD Planetarium, P.O. Box 2680, 97402. Cuyla Shelton, (503) 345-7748.

Portland — OMSI Astronomers. 4015 SW Canyon Road, 97221. John Buting, (503) 228-OMSI.

Portland — Portland Astronomical Society. 2626 SW Luradel, 97219. Don Botteron, (503) 245-6251.

Veronia — Northwest Astronomy Group. 55371 McDonald Road, 97064. Sandy Mikalow.

PENNSYLVANIA

Allentown — Lehigh Valley Amateur Astronomical Society, Inc. 620 East Rock Road, 18103. Robert Mohr, (215) 797-3476.

East Pittsburgh — American Lunar Society. P.O. Box 209, 15112. Theresa Palmer, (412) 829-7455.

Glenshaw — Amateur Astronomers Association of Pittsburgh. P.O. Box 314, 15116. John Holtz, (412) 224-2510.

Kane — Sir Isaac Newton Astronomical Society. Box 591, 16735. William Bloom, (814) 837-6137.

Lansdale — L5 Society of Philadelphia. 1825 Flintlock Circle, 19446. Jay B. Haines, (215) 855-7130.

Lewisberry — Astronomical Society of Harrisburg. P.O. Box 356, 17339. (717) 938-6041.

New Brighton — Beaver Valley Astronomy Club. 818 6th Avenue, 15066. Charles A. Sabella, (412) 843-8931.

New Kensington — Kiski Astronomers. 2 Aluminum City Terrace, 15068. Dennis Sopchack, (412) 337-0509.

Philadelphia — Delaware Valley Amateur Astronomers. 6233 Cator Avenue, 19149. Bob Summerfield, (215) 831-0485.

Philadelphia — Rittenhouse Astronomical Society. P.O. Box 12531, 19131. Milt Friedman, (215) 886-3466.

Reading — Berks County Amateur Astronomical Society. Reading School District Planetarium, 1211 Parkside Drive South, 19611.

Scranton — Lackawanna Astronomical Society. 1047 Mohawk Street, 18508. John D. Sabia, (717) 586-0789.

RHODE ISLAND

Cumberland — Aurora Alert Hotline. 57 Manville Hill Road #10, 02864. David A. Huestis, (401) 765-5778.

Greenville — Skyscrapers, Inc. P.O. Box 814, 02828. Bob Napier, (401) 934-0980.

SOUTH CAROLINA

Aiken — Aiken Astronomy Club. USC-Aiken, Building 106, 171 University Parkway, 29801. Richard M. Albert, (803) 663-3105.

Columbia — Midlands Astronomy Club. 321 Watermark Place, 29210. Doug Lybrand, (803) 799-8703.

Rock Hill — Carolina Skygazers Astronomy Club. 4621 Mount Gallant Road, 29730. M. Leon Knott, (803) 329-2121.

SOUTH DAKOTA

Rapid City — Black Hills Astronomy Society. 4912 Breckenridge Court, 57702. Michael O'Connor, (605) 342-3793.

TENNESSEE

Brentwood — Barnard-Seyfert Astronomical Society. A. J. Dyer Observatory, 1000 Oman Drive, 37027. A. M. Heiser, (615) 373-4897.

Chattanooga — Barnard Astronomical Society. P.O. Box 90042, 37412. F. Randolph Helms, (615) 622-4762.

Kingsport — Bays Mountain Amateur Astronomers. Route 4, 37660. (615) 229-9447.

Knoxville — Meteorical Society. Department of Geological Sciences, University of Tennessee, 37996.

Knoxville — Orion Research Forum and Network. P.O. Box 50291, 37950. Bob Miles, (615) 482-3829.

Knoxville — Smoky Mountain Astronomical Society. P.O. Box 6204, 37914-0204. Rita Fairman, (615) 637-1121.

Manchester — Middle Tennessee Astronomy Society. 1305 Sycamore Drive, 37355. Donald W. Male, (615) 728-7321.

Memphis — Memphis Astronomical Society. 1229 Pallwood Road, 38122. Richard Moore, (901) 682-2003.

Tullahoma — Middle Tennessee Astronomical Society. 113 Crestwood, 37388. Martin Nelius, (615) 455-5132.

TEXAS

Abilene — Abilene Astronomical Society, Inc. 1109 Highland Avenue, 79605. George Schroeder, (915) 677-5713.

Amarillo — Amarillo Astronomy Club. 4324 Summit Circle, 79109. Danny Zumbrun.

College Station — Association of Amateur Astronomers. Texas A&M University, Department of Physics, 77843-4242. Roger Smith, (409) 845-4179.

Corpus Christi — Corpus Christi Astronomical Society. 3814 Marion Street, 78415. Gary Mayer, (512) 852-7643.

Dallas — Texas Astronomical Society. P.O. Box 25162, Preston Station, 75225. Sharon Cherry, (214) 358-6982.

Fort Worth — Fort Worth Astronomical Society. P.O. Box 161715, 76161-1715.

Fort Worth — General Dynamics Astronomy Club. 3400 Bryant-Irvin Road, 76109. Ronald W. Evans, (817) 763-6244.

Fort Worth — Texas Observers. Fort Worth Museum of Science and History, 1501 Montgomery Street, 76107. Don Garland, (817) 732-1631.

Houston — Houston Astronomical Society. 8522 Bluegate Drive, 77025. (713) 661-6180.

Houston — Students for the Exploration and Development of Space, University of Houston, 2700 Bay Area Boulevard. Box 198, 77058. Carlos Perez, (713) 486-9359.

Lake Jackson — Brazosport Astronomical Society. 500 College Drive, 77566. Steve Lamb, (409) 297-3984.

Lubbock — South Plains Astronomy Club. 1920 46th Street, 79412-2214. Wayne Lewis, (806) 763-6800.

San Angelo — San Angelo Amateur Astronomers. P.O. Box 60391, 76906. Larry Baker, (915) 944-3148.

Sanger — Denton County Astronomical Society. 225 Green Springs Circle, 76266. John Love, (817) 458-7479.

Stafford — Fort Bend Astronomy Club. P.O. Box 942, 77477-0942. Dennis Zwicky, (713) 499-4993.

Texas City — College of the Mainland Astronomy Club. Division of Math, Health, and Natural Science, 77591. John L. Hubisz, (409) 938-1211 extension 325.

Tyler — Astronomical Society of East Texas. Route 14, Box 394-A, 75707. Larry Scott.

UTAH

Cedar City — Southern Utah Astronomy Group. 147 South 300 East, 84720. Brent Sorensen, (801) 586-2759.

Roy — Ogden Astronomical Society. 2336 West 5650 South, 84067. Bob Tillotson, (801) 773-8106.

Salt Lake City — Salt Lake City Astronomical Society. 15 South State Street, 84111. David Bernson, (801) 467-2126.

VIRGINIA

Burke — Northern Virginia Astronomy Club. 6028 Ticonderoga Court, 22015. John Scott Huggins, (703) 866-4985.

Chesapeake — Back Bay Amateur Astronomers. 2808 Flag Road, 23323. Glendon L. Howell, (804) 485-4242.

Chesapeake — Tidewater Community College Astronomical Society. 3065 Stratford Drive, 23321. Dennis Rowley, (804) 483-3822.

Fredericksburg — Triangulum Astronomical Society. P.O. Box 7464, 22404. Al Ventura, Jr., (703) 775-2337. (201) 752-1309.

Hampton — Langley Skywatchers. 221 Raleigh Avenue, 23661. Charles Evans.

Harrisonburg — Shenandoah Valley Astronomy Club. James Madison University, Department of Physics, 22807. Henry W. Leap, (703) 568-6109.

Lynchburg — Lynchburg Astronomy Club. 4648 Locksview Road, 24503. Allen Majewski, (804) 384-5616.

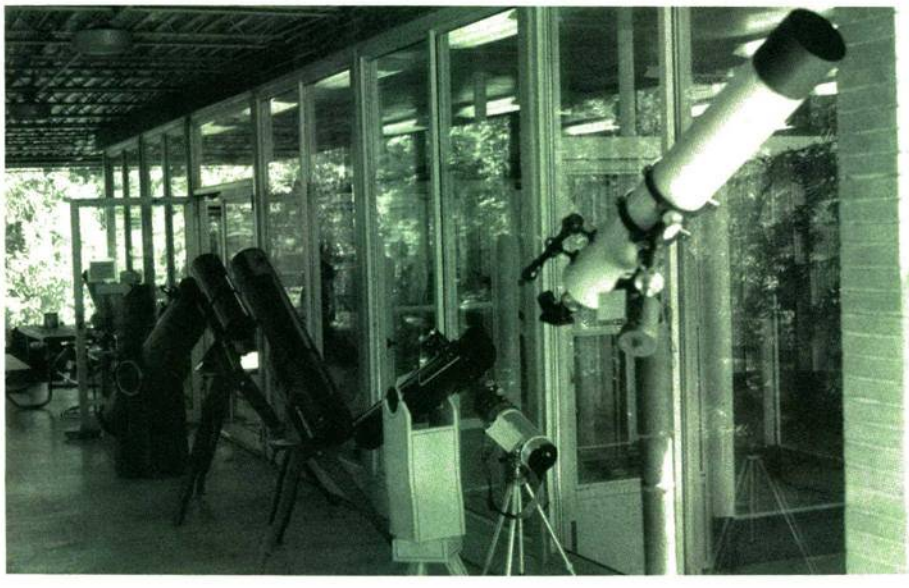
Portsmouth — Astronomical Society of Tidewater. 2216 County Street, 23704. Leonard W. Scarr, (804) 397-6241.

Reston — Nova Space Society. 11208 Chestnut Grove Square #5, 22090-5105. Gary Sanger, (703) 435-0019.

Virginia Beach — Tidewater Amateur Telescope Makers. 677 Charlecote Drive, 23464. Don Wright, (804) 424-9430.

VERMONT

Essex Junction — Vermont Astronomical Society. 115 Sherwood Square, 05452. Russell Chmela, (802) 878-3459.



AMATEUR TELESCOPES are proudly displayed at the Apollo Rendezvous and Telescope Fair in Dayton, Ohio.

SCENIC WESTERN CANADA is the setting for the Mount Kobau Star Party in Okanagan Valley, British Columbia.

Williston — Vermont Astronomical Society. P.O. Box 782, 05495. Brad P. Vietje, (802) 425-2638.

WASHINGTON

Centralia — Southwest Washington Astronomical Society. 2421 Leisure Lane, 98531. Carl M. Newton, (206) 736-6144.
Keyport — Olympic Astronomical Society. P.O. Box 458, 98345. Jim Sykes, (206) 698-0381.
Richland — Tri-City Astronomy Club. 1725 Birch, 99352. Thomas L. Page. (509) 946-9803.
Seattle — Boeing Employees' Astronomical Society. The Boeing Company, P.O. Box 3707, Mail Stop 1E-58, 98124. J. Eric Holcomb, (206) 852-9133.
Spokane — Spokane Astronomical Society. 54140 Cook, 99223. Bob Lemley, (509) 448-9694.

WISCONSIN

Appleton — Northeast Wisconsin Stargazers (Newstar). 109 Skyline Drive, 54915. Bob Schmall.
Chippewa Falls — Chippewa Valley Astronomy Society. P.O. Box 21, 54729. Peter Peloquin, (715) 723-7862.
Franklin — Wehr Astronomical Society. 9701 West College Avenue, 53132. Karen Kerans, (414) 425-8550.
La Crosse — La Crosse Area Astronomical Society. P.O. Box 2041, 54602-2041. Robert Allen, (608) 785-8669.
Madison — Madison Astronomical Society, Inc. 205 Cameo Lane, 53714-2514. David D. Weier, (608) 241-1444.
Racine — Racine Astronomical Society. 5226 Athens Avenue, 53406. Marilynn Theilman.
Waukesha — Milwaukee Astronomical Society. W248 S7040 Sugar Maple Drive, 53186. (414) 542-9071.

WYOMING

Cheyenne — Cheyenne Astronomical Society. 3409 Frontier Street, 82001. Marcy Flint, (307) 632-2717.

CANADA

ALBERTA

Calgary — Royal Astronomical Society of Canada-Calgary Centre. Calgary Planetarium, P.O. Box 2100, Station M, T2P 2M5.
Edmonton — Royal Astronomical Society of Canada-Edmonton Centre. Mel Rankin, 4203-10613 Avenue, T6A LK7.
Fort McMurray — Astronomical Society of Fort McMurray. 228 Grenoble Crescent, T9H 3X8. Shelia Callan, (403) 743-9178.
Lethbridge — Lethbridge Astronomy Society. P.O. Box 1104, T1J 4A2. Rick Ponomar.

BRITISH COLUMBIA

Prince George — Prince George Astronomical Society. College of New Caledonia, 3330-22nd Avenue, V2N 1P8. Bob Nelson, (604) 562-2131.
Vancouver — Royal Astronomical Society of Canada-Vancouver Centre. Gordon Southam Observatory, 1100 Chestnut Street, V6J 3J9.
Vernon — Okanagan Astronomical Society. 4100 25th Avenue, V1T 1P4. Peter Kuzel, (604) 545-1226.
Victoria — Royal Astronomical Society of Canada-Victoria Centre. 801 Stanehill Place, Rural Route #1, V8X 3W9. A. Newton, (604) 478-8065.

MANITOBA

Brandon — Brandon Amateur Astronomy Club. 32 Ashgrove Boulevard, R7B 1C2. (204) 726-8294.
Winnipeg — Manitoba Astronomy Club. 190 Rupert Avenue, R3B 0N2. Doug Knight, (204) 956-2830.
Winnipeg — Royal Astronomical Society of Canada-Winnipeg Centre. P.O. Box 215, St. James Post Office, R3J 3R4. John Haines, (204) 275-0376.

NEWFOUNDLAND

Mount Pearl — Royal Astronomical Society of Canada-St. John's Centre. P.O. Box 944, A1N 3C9. Peter Allston.

NOVA SCOTIA

Halifax — Royal Astronomical Society of Canada-Halifax Centre. 1747 Summer Street, B3H 3A6. Douglas Pitcairn, (902) 463-7196.

ONTARIO

Ottawa — Royal Astronomical Society of Canada-Ottawa Centre. P.O. Box 6617, Station J, K2A 3Y7. Doug George, (613) 591-3119.
St. Catharines — Royal Astronomical Society of Canada-Niagara Centre. 24 Hawthorne Avenue, L2M 6A9. John Dekker, (416) 934-7210.
Sudbury — Sudbury Astronomy Club. 859 Chestnut Crescent, P3A 5B3. Fred Boyer, (705) 560-3265.
Toronto — North York Astronomical Association. 26 Chryessa Avenue, M6N 4T5. Andreas Gada.
Toronto — Royal Astronomical Society of Canada-Toronto Centre. McLaughlin Planetarium, 100 Queen's Park, M5S 2C6. Guy Nason, (416) 222-4814.
Waterdown — Royal Astronomical Society of Canada-Hamilton Centre. P.O. Box 1223, L0R 2H0. Eric Golding.
Waterloo — Royal Astronomical Society of Canada-Kitchner-Waterloo Centre. 114 Westvale Drive, N2T 1J2. Paul Bigelow, (519) 888-7516.

QUEBEC

Montreal — La Societe d'Astronomie de Montreal. Casier Postal 206, Station St-Michel, H2A 3L9. Marc A. Gelinas, (514) 453-0752.
Montreal — Royal Astronomical Society of Canada-Montreal Centre. P.O. Box 1752, Station B, H3B 3L3. Louie Bernstein, (514) 845-2612.

SASKATCHEWAN

Saskatoon — Royal Astronomical Society of Canada-Saskatoon Centre. Box 317, Sub. P.O. Box #6, S7N 0W0. Jim Young, (306) 652-1536.

ASTRONOMY

1989 Summer Meetings and Events

There's a lot happening this summer that you won't want to miss: a total lunar eclipse, the Perseid meteor shower, *Voyager* at Neptune, Spaceweek activities, telescope fairs, and, of course, star parties.

May 5-6
Arkansas Star Party, near Fort Smith, Arkansas. Sponsored by the Arkansas-Oklahoma Astronomical Society. Contact: Larry Kennedy, Route 3, Box 421W, Pocola, OK 74902. Phone: (918) 436-2204.

May 5-7
Astronomy Weekend, Blackwater Falls State Park, Davis, West Virginia. Contact: Pat Northeimer, Blackwater Falls State Park, P.O. Davis, WV 26260. Phone: 1-800-CALL WVA.

May 12-13
Astronomy Fest '89, Vestal, New York. Sponsored by the Kopernik Astronomical Society. Contact: Roberson-Kopernik Observatory, Underwood Road, Vestal, NY 13850. Phone: (607) 772-0660.

May 13
16th Annual Astronomy Day. Contact: Gary E. Tomlinson, Astronomy Day Coordinator, Astronomical League, Chaffee Planetarium, 54 Jefferson Avenue SE, Grand Rapids, MI 49503. Phone: (616) 456-3985. Also contact your local astronomy club, planetarium, observatory, or museum for details on scheduled events.

May 20
9th Annual Summer Telescope Demonstration and Star Party, Oceanside, California. Sponsored by the Oceanside Photo and Telescope Astronomical Society. Contact: Penny Hauck, 1024 Mission Avenue, Oceanside, CA 92054. Phone: (619) 723-0684.

May 24-26
1989 I.A.P.P.P. Big Bear Symposium, Big Bear Lake, California. Contact: Roger DeYoe, 3416 Genevieve Street, San Bernardino, CA 92405. Phone: (714) 883-9807.

May 26-29
Riverside Telescope Makers Conference, Camp Oakes, Big Bear, California. Contact: Cliff Holmes, 8642 Wells Avenue, Riverside, CA 92503. Phone: (714) 689-6893.

May 29-June 4
Texas Star Party, Prude Ranch, Fort Davis, Texas. Contact: T.S.P. Registrar, Bobby Braley, Department "A," P.O. Box 386, Wylie, TX 75098.

June 2-4
Front Range Super Cluster Star Party, Medicine Bow Forrest, Wyoming. Sponsored by the Denver, Longmont, Boulder Valley, Colorado Springs, and Cheyenne astronomical societies. Contact: Marcy Flint, 3409 Frontier Street, Cheyenne, WY 82001. Phone: (307) 632-2717.

June 9-10
19th Annual Apollo Rendezvous and Telescope Fair, Dayton, Ohio. Sponsored by the Miami Valley Astronomical Society and the Dayton Museum of Natural History. Contact: Ian Dumbauld, MVAS, 2629 Ridge Avenue, Dayton, OH 45414. Phone: (513) 837-4600.

June 16-18
14th Annual Meeting of the Association des Groupes d'Astronomes Amateurs, Laval, Quebec. Hosted by the Club d'astronomie Espace de Montreal, the Club des astronomes amateurs de Laval, and the Club d'astronomie MIRA, Inc. Contact: Congress '89, A.G.A.A., P.O. Box 1000, Station M, Montreal, Quebec, Canada H1V 3R2. Phone: (514) 625-5527.

June 21-25
Centennial Meeting of the Astronomical Society of the Pacific, University of California at Berkeley. Contact: Berkeley Meeting Information, A.S.P., 390 Ashton Avenue, San Francisco, CA 94112.

June 23-24
4th Annual Sedona-Verde Valley Astrophotography Festival, Verde Valley Preserve of Thousand Trails, Arizona. Contact: Russell A. Nidey, 1101 Zalesky Road, Cottonwood, AZ 86326.

June 24
Annual Summer Solstice Celebration and Star Party, East Detroit, Michigan. Sponsored by the Warren Astronomical Society. Contact: Alan Rothenberg, P.O. Box 474, East Detroit, MI 48021. Phone: (313) 344-2854.

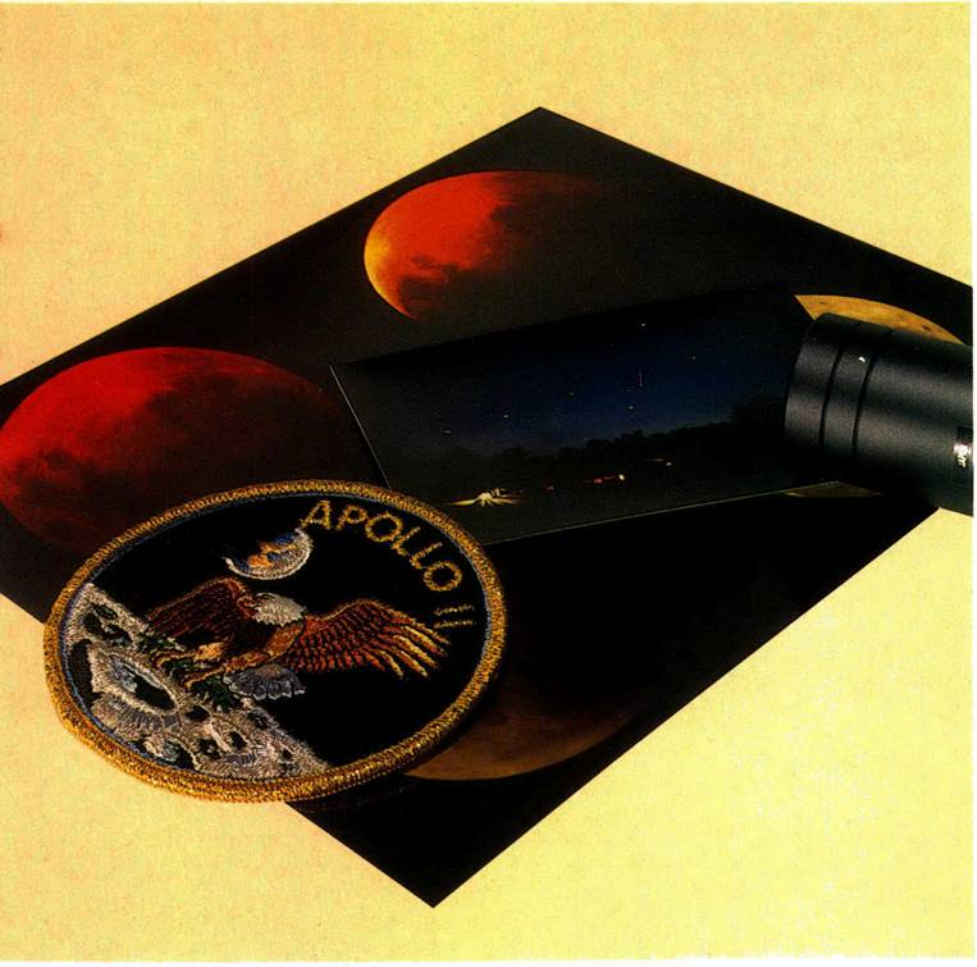
June 24
The Great Snowball Melt, Discovery Center, Syracuse, New York. Contact: Stephen A. Karon, 321 South Clinton Street, Syracuse, NY 13202. Phone: (315) 425-9068.

June 30-July 2
Astronomical League Mid-States Regional Convention, Tulsa, Oklahoma. Sponsored by the Astronomy Club of Tulsa. Contact: Newel Pottorf, 3832 South Victor, Tulsa, OK 74105. Phone: (918) 742-7577.

July 1
Star Bash, Huntsburg, Ohio. Sponsored by the Chagrin Valley Astronomical Society. Contact: Don Himes, P.O. Box 11, Chagrin Falls, OH 44022. Phone: (216) 247-5114.

July 1-31
Moon-Moonta, West Palm Beach, Florida. 20th anniversary celebration of *Apollo 11* sponsored by the South Florida Science Museum and the Astronomical Society of the Palm Beaches, Inc. Contact: Gary Bogner, 4801 Dreher Trail North, West Palm Beach, FL 33405. Phone: (407) 832-1988.

July 8
Annual Convention of the Cuyahoga Astronomical Association, Hiram, Ohio. Contact: Allen Jenks, P.O. Box 29089, Parma, OH 44129. Phone: (216) 237-4223.



July 16-24 — Spaceweek
Space celebrations held throughout North America. Contact your local astronomy club, planetarium, observatory, or museum for details on events.

July 19-23
Astronomical League National Convention, Spokane, Washington. Hosted by the Spokane Astronomical Society. Contact: Bob Lemley, 54140 Cook, Spokane, WA 99223. Phone: (509) 448-9694.

July 28-29
2nd Annual Ozarks Star Party, near Branson, Missouri. Sponsored by the Ozarks Telescope Makers and Amateur Astronomers. Contact: Greg Blount, P.O. Box 165, Cape Fair, MO 65624. Phone: (417) 538-4553.

July 28-29
14th Annual Public Star Night, Saskatoon, Saskatchewan. Sponsored by the Royal Astronomical Society of Canada-Saskatoon Centre. Contact: Jim Young, Box 317, Sub P.O. #6, Saskatoon, Saskatchewan, Canada S7N 0W0.

August 1
Annual Star Party, Santa Barbara, California. Sponsored by the Santa Barbara Astronomy Club. Contact: Clyde Kirkpatrick, P.O. Box 3702, Santa Barbara, CA 93130. Phone: (805) 685-2705.

August 4-6
Mountain Astronomers Rendezvous and Star Party (MARS), Royal Gorge, Canon City, Colorado. Sponsored by the MARS region of the Astronomical League. Contact: Dave Trott, P.O. Box 10814, Denver, CO 80210. Phone: (303) 871-5172.

August 5
Stellafane, Springfield, Vermont. Contact: Stellafane, 60 Victoria Road, Sudbury, MA 01776.

August 5-6
Northwoods Starfest, Fall Creek, Wisconsin. Sponsored by the Chippewa Valley Astronomical Society. Contact: Preston J. Bush, Chippewa Valley Astronomical Society, 601 Vine Street, Eau Claire, WI 54703.

August 7-11
Astronomy Camp, Virginia Living Museum, Newport News, Virginia. For children ages 12-14, registration deadline: August 1. Contact: Jon U. Bell, 524 J. Clyde Morris Boulevard, Newport News, VA 23601. Phone: (804) 595-1900.

August 10-13
Rocky Mountain High: The Alberta Star Party 1989, Waterton Lakes International Peace Park, Alberta. Hosted by the Lethbridge Astronomy Society. Contact: Registrar, P.O. Box 1104, Lethbridge, Alberta, Canada T1J 4A2.

August 12 — Perseid Meteor Shower
Meteor watches held throughout North America. Contact your local astronomy club, planetarium, observatory, or museum for details on events.

August 16 — Total Lunar Eclipse
Eclipse watches held throughout North America. Contact your local astronomy club, planetarium, observatory, or museum for details on events.

August 19
Annual Telescope Making Contest, Montreal, Quebec. Sponsored by the La Societe d'Astronomie de Montreal. Contact: Marc A. Gelinas, Casier Postal 206, Station St. Michel, Montreal, Quebec, Canada H2A 3L9. Phone: (514) 728-4422.

August 23-27
Planetfest, Pasadena, California. *Voyager 2* at Neptune events sponsored by the Planetary Society. Contact: Susan Lendroth, 65 North Catalina Avenue, Pasadena, CA 91106. Phone: (818) 793-5100.

August 25-26
Starfest '89, Mount Forest, Ontario. Sponsored by the North York Astronomical Association. Contact: Andreas Gada, 26 Chryessa Avenue, Toronto, Ontario, Canada M6N 4T5.

August 25-27
3rd Annual Astronomy Rendezvous and Conference, Normal, Illinois. Sponsored by the Twin City Amateur Astronomers, Inc. Contact: Donald F. Johnson, P.O. Box 755, Normal, IL 61761. Phone: (309) 452-3866.

August 25-27
The Conjunction, Northfield Mountain Environmental Center, Northfield, Massachusetts. Contact: Jack Megas, 311 Surrey Road, Springfield, MA 01118.

August 25-28
Nova East '89, Fundy National Park, New Brunswick. Sponsored by the Royal Astronomical Society of Canada-Halifax Centre. Contact: Doug Pitcairn, 1747 Summer Street, Halifax, Nova Scotia, Canada B3H 3A6. Phone: (902) 463-7196.

August 26
Public Stargaze, Richland, Washington. Sponsored by the Tri-City Astronomy Club. Contact: Thomas L. Page, 1725 Birch, Richland, WA 99352. Phone: (509) 946-9803.

August 30-September 3
6th Annual Mount Kobau Star Party, Okanagan Valley, British Columbia. Contact: Peter Kuzel, 4100 25th Avenue, Vernon, British Columbia, Canada V1T 1P4. Phone: (604) 545-1226.

September 1-4
7th Annual Eastern Iowa Star Party, Maquoketa, Iowa. Sponsored by the Quad Cities Astronomical Society. Contact: Dana Taylor, P.O. Box 3706, Davenport, IA 52808. Phone: (319) 322-2557.

ASTRONOMY Tests Celestron's Ultima 8

We've rigorously performance-tested the new Ultima 8 to give you an inside look at this new 8-inch Schmidt-Cassegrain.

by Robert Burnham

When Celestron's Ultima 8 appeared on the market last fall, it was claimed to be "the finest 8-inch Schmidt-Cassegrain telescope in the world." To evaluate this claim for our readers, ASTRONOMY requested a sample of the telescope for review, on the understanding that the one sent to us would be identical to those sold to the general public.

For most backyard astronomers the Ultima 8 falls into the category of a "serious" telescope. This means anyone who considers buying an Ultima plans to make a major outlay in return for a sophisticated, high-quality instrument that will increase his or her enjoyment of the hobby. Because no one makes such a purchase lightly, our goal was to compare Celestron's claims to the Ultima's performance.

We looked at several specific areas:

Is the optical system "simply the best you can buy"?

Is the tripod "rock-solid"?

How well does the drive track the sky?

What is using telescope like?

Providing straight answers to these questions, we felt, would help anyone considering an Ultima make up his or her mind.

Not to keep you in suspense, we found that the Ultima 8 is indeed a fine telescope, although certain shortcomings prevent it from meeting all the claims made for it. Optically it performed very well and its mechanical parts generally did likewise. We feel, however, that aspects of the finder scope's design and of the slow-motion controls were deficient. The drive also contained a periodic error that will hamper astrophotography, and the carrying case was inadequate for its job.

We didn't purposely choose to test the telescope in winter, but under the circumstances it worked out well because field tests done in cold weather provide a more stringent test of how well a telescope performs. For example, undersize controls that are easy to manipulate barehanded at 60° F become problems at 20° when you are wearing gloves. Temperatures during our tests were generally in the teens and wind speeds ranged from still to 30 miles per hour in gusts. Seeing averaged a few arcseconds.

We report first on the optics, then the mounting and drive, followed by the entire telescope's operation, and, last, the design of the accessories and carrying case.

RELATIVELY COMPACT like all Schmidt-Cassegrains, the Ultima 8 (shown with ASTRONOMY's Jeff Kanipe) comes in the three cartons below. Loaded with telescope and fork, the black carrying case weighs 55 pounds.

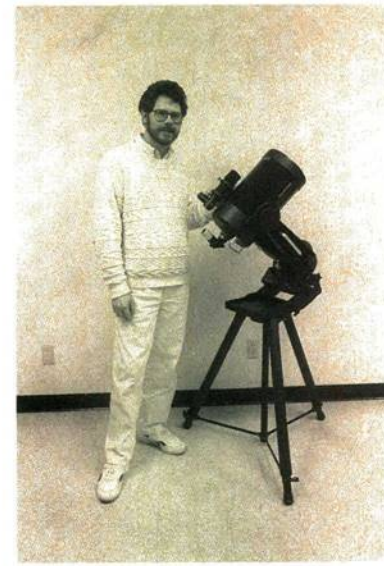
Optics

The Ultima 8's f/10 optics are very good. Out-of-focus star images are clean, even circles with a central dark spot that stays almost dead center

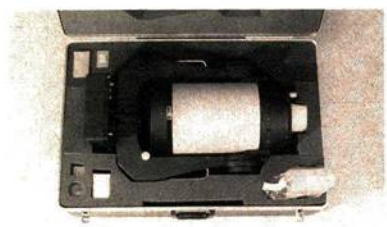
when you run through focus and back out the other side (see photos on page 82). As with any telescope, it is important to let the instrument adjust to the outdoor temperature. Even a closed-tube system is not free from temperature effects because optical parts can be placed under stress as they cool and will not deliver good images. The Ultima's images showed a slight flare before the temperature equalized inside and out.

The mirror and corrector plate coatings appear to work well. A classic test for glare and scattered light is spotting the 7th-magnitude companion to Rigel; it was clearly visible at magnifications from 67x to 508x. Turned on Jupiter, our sample Ultima delivered a crisp image with good contrast. Small irregularities in the edges of the equatorial belts were visible at 508x and, after allowing the eye to adjust for several minutes, we saw soft pastel tans and browns. Are these optics the "best you can buy"? That's impossible to say, but they *are* very good.

There is, however, an image shift of about 1′ that occurs whenever you turn the focus knob in the reverse direction from the previous turn. If you habitually focus a telescope (as many do) by rocking back and forth through the focus point and then closing in on it, the "hop" in the image is very annoying, even at low magnification. At high powers it is enough to make an object hop away from the center of the field. This image shift is common in Schmidt-Cassegrains, because they focus by moving the primary mirror in and out. A novice owner would probably find the shift disconcerting, but we found we got used to it in time, although it was always noticeable.



AT THE TRIPOD'S MAXIMUM EXTENSION the eyepiece height is convenient, but we found acceptable stability only with the legs fully retracted.



SURROUNDED BY ACCESSORIES, the Ultima plus fork mounting and drive fit into the plastic foam-lined carrying case.

A FLIMSY-LOOKING HANDLE on the carrying case worries us: those four small rivets support 55 pounds. Will the handle hold up under years of use?

Tripod and Mounting

Assembling the Ultima 8 went smoothly after we received the correct instruction booklet. (The scope was originally shipped with the instructions for a Powerstar C8.) The manual runs thin on pictures, but the descriptions are clearly written and we think it unlikely that even beginners will go astray, particularly if they read the manual carefully before unpacking.

If you have assembled a C8 before, the Ultima holds no surprises, and novices will find the job goes quickly. Start by erecting the tripod. Spread the feet and slide the leg brace all the way down the central column as far as it goes. The tripod legs have large rubber "crutch tips" that provide a good, if springy grip on a smooth, hard surface like concrete or terrazzo. However, they will not bite into a surface such as hard-packed dirt, for which metal spikes are necessary. (A truly versatile tripod would have both kinds of tips, so you could choose between them, depending on the circumstances.) The rubber tips can be removed, but years of being jammed into dirt will probably damage the tubular ends of the legs. The tubes have walls only $\frac{1}{16}$-inch thick and will bend if subjected to mishandling.

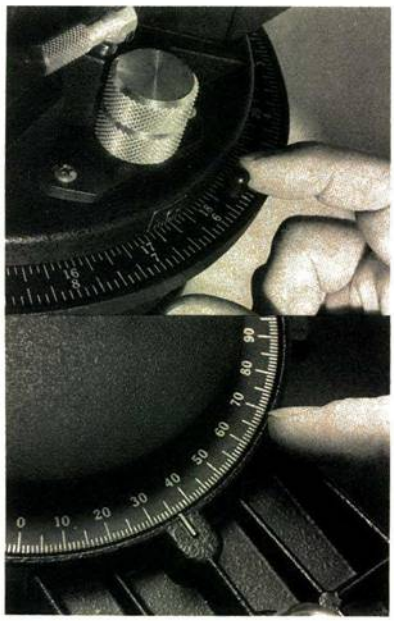
The tripod legs extend about two feet and have thumbscrews for locking the legs at any extension. The manual says it's okay to extend the legs for casual observing but recommends retracting them fully for astrophotography. We would amend that to read "don't ever extend them." With the legs fully extended, the eyepiece (pointing at the zenith with a star diagonal in place) lies 62 inches above the ground — comfortably close to eye height for most adults. But while this made observing convenient, it contained a major drawback: we found that with fully extended legs, a light tap on the tube, such as a gust of wind might give, made a 70x image dance around to an annoying degree. (The motion is greater, of course, at higher magnification.) The vibrations died away in three to four seconds, but this movement is more than many people would tolerate, even for casual observing.

Pulling the legs all the way in dropped the eyepiece height to 39 inches — low enough that you have to perch on a low stool to view the zenith in comfort. While more awkward, this greatly lessened the vibration problem, and the shakes then died out in about one second. Some of the remaining vibration may be due to the sliding fit of the leg brace on the central column. When we pushed down on the tripod head and twisted, the head moved slightly — movement that would translate into image motion at the eyepiece. Perhaps if the leg brace could be clamped onto the central column, the vibration would be diminished. In any case, this tripod is not "rock-solid".

The wedge attaches to the tripod head in either of two positions. The first places the wedge's tilt plate (to which the telescope itself bolts) over one of the tripod legs; the other places it between two of them. We found the former to be a better arrangement

GRAB HANDLES and a stiffer fork are new features of the Ultima 8.

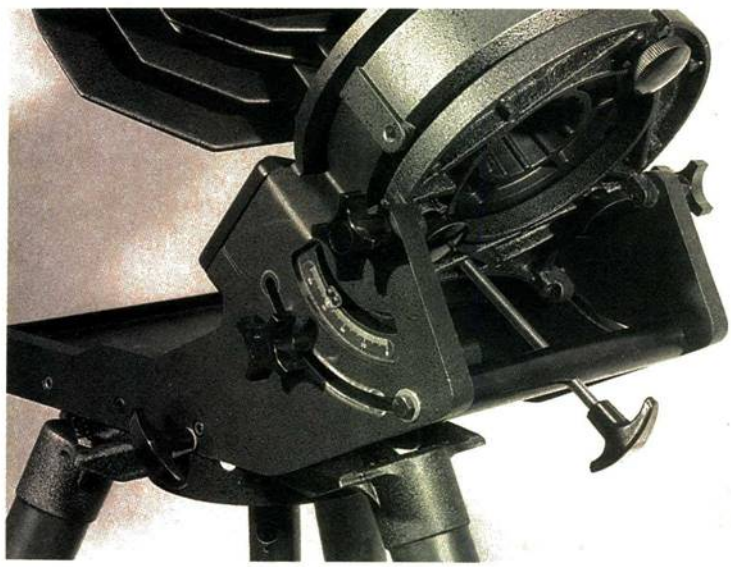
A HANDY ACCESSORY TRAY is part of the wedge.



FINGER-ADJUSTABLE, the right ascension setting circle has markings every 5 minutes. Declination circles are marked at 1° intervals.

RUBBER CRUTCH TIPS on the tripod cannot provide a good grip on dirt. But removing the tips to jam the legs into the ground will probably damage the tubing.

TIGHT CLEARANCES make the right ascension lock lever and slow-motion knob hard to operate with gloves on.



POLAR ALIGNMENT: T-handle A adjusts the azimuth aim, while T-handle B elevates the polar axis.

because it carries the weight of the scope most directly to the ground and provides a work area for the observer between the two tripod legs on the north side.

A small problem emerged when we attached the wedge to the tripod top. The wedge fastens on with three 5/16-18 bolts that need a ¼-inch Allen wrench to tighten them, but this size wrench was not included in the set provided with the telescope. Although our toolbox had one and the wrenches are available in every hardware store, we noted the omission.

One of the telescope's new features — three handles, one on each of the fork tines and one at the eyepiece end of the tube — provides you with a secure grip on the telescope. These come in handy when you hoist the tube and fork assembly into place on the wedge and when you are disassembling the scope. In addition, the handle on the tube means you don't have to grab precision parts (such as an eyepiece or finder) when you wish to slew the telescope. Good feature.

Testdriving the Ultima

One of the Ultima's innovations is a battery pack built into the drive housing. This frees the telescope from umbilical cords and gives you about eight hours of power at any site. The batteries also appear to supply ample power even under the cold conditions noted above, although we did not run the mounting outdoors for eight hours straight. Celestron says the batteries are good for 500 charges. When the batteries (two D cells) no longer take a charge, remove the cover to the drive and replace them. They discharge about twice as fast as they recharge, so plugging in the charging adaptor for sixteen hours restores them when they are completely flat.

We tested the mounting's tracking ability by aligning the mount on the pole, turning on the drive, setting the variable drive rate to "sidereal," and centering a star (Rigel) in a 4mm eyepiece (508x). We then observed the tracking.

With a good polar alignment, the drive kept Rigel in the field, although it appeared to move back and forth. This led us to suspect a periodic error in the drive, which we confirmed with a 10-minute unguided photo taken of the Orion Nebula with eyepiece projection (see page 82). To make the tracking error more visible, we deliberately misaligned the scope on the pole. Star trails, which should be straight lines if the drive had no periodic error, have a jog in them about every four minutes.

Visually an object centered in the field remains centered for about four minutes. It then slips westward about 30" and recovers promptly. Then, about 15 seconds after recovery, it again drifts 30" westward and recovers once more. Four minutes then pass and the sequence repeats. While this periodic error would create difficulties in astrophotography or photometry, we think most people would find it acceptable for visual observations.

The mounting comes with setting circles divided at intervals of 1° (declination) and 5 minutes (right ascension). The indicator mark for the right ascension circle has a rough vernier that lets you read to about 2 minutes; it is printed on a sheet of thin aluminum glued to the drive housing. The indicator on our sample telescope was not attached perfectly square, but it worked adequately nonetheless.

Shifting the telescope's aim is done in any of three ways, depending on how far you want to move the telescope. The biggest movements — slewing from Orion to Jupiter, say — are done by loosening the locks on the right ascension and declination axes, swinging the telescope to the new object, and tightening the locks.

Small motions, needed for taking astrophotographs, typically call for slight adjustments of the drive rate. The Ultima's drive has a built-in right ascension controller that adjusts the speed of the motor and is operated by a paddle you hold in your hand. The paddle has four buttons (N, S, E, and W) plus a knob you turn to adjust the speed at which the mounting tracks the sky's motion; solar, sidereal, and lunar rates are marked. The control paddle and corrector worked well, although without a declination drive installed, we could test only its control in right ascension.

For centering an object that may be one or two fields of view away, the observer uses the right ascension and declination slow-motion controls. These manually shift the telescope's pointing. On the Ultima, the controls do their job well: the declination motion is smooth with a good fine pitch that makes small aiming adjustments easy. It has 15° of total travel. The right ascension motion (360° of travel) works equally smoothly, but the knob is hard to turn while you are wearing gloves because it lies close to the fork and the lever that locks its motion. In addition, the lock is difficult to loosen with gloves on.

These locks gave us a little concern. Many times the telescope will be used off-balance, inadvertently or through ignorance, as, for instance, when a heavy camera is attached, either piggyback or at the focuser. If the locks on the axes do not hold tightly, the telescope will slip, perhaps abruptly. The right ascension lock never felt really tight to us, and while the declination lock snugged up tighter, it still did not feel completely secure.

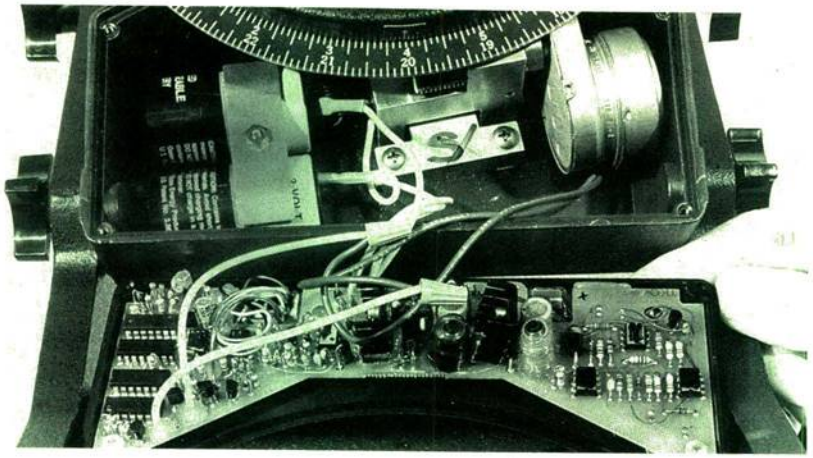
THE FINDER SCOPE offers choice of right-angle or straight-through viewing.

CONVERTING THE FINDER from right-angle to straight-through means fiddling with a tiny set screw — not easy with chilled or gloved fingers.

AN EASY-TO-LOSE BATTERY and a clumsy switch make the finder's lighted reticle harder to use.

Ease of Use

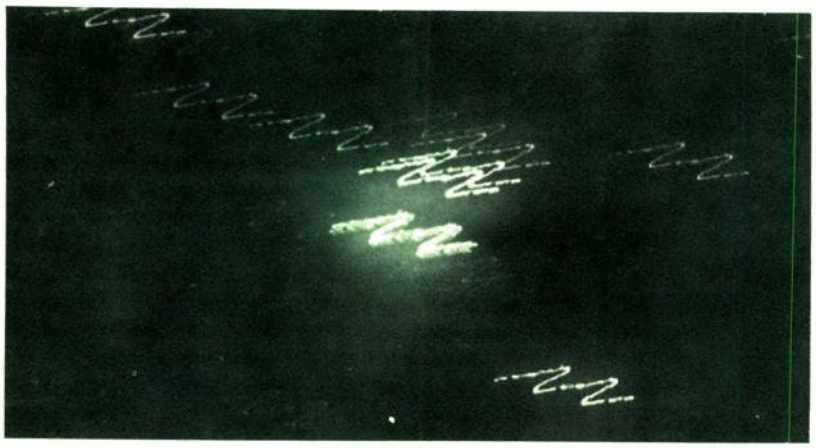
Schmidt-Cassegrains in general are



INSIDE THE DRIVE HOUSING, two rechargeable D cells provide power to the drive.

FITTING THE PALM OF YOUR HAND, the drive corrector's controller paddle offers adjustable tracking rates plus declination motion with a separate motor.

THE "DASHBOARD" for the Ultima is on the drive housing.



A PERIODIC ERROR in the drive turned star trails into squiggles during this unguided 10-minute exposure on the Orion Nebula (see text).

BETELGEUSE TESTS the Ultima's optics inside, at, and outside focus. The clean star disk shows the mirror's good figure.

easy telescopes to use and the Ultima is true to its breed. They are well adapted for astrophotography and put a long focal length into a short, transportable tube. We found the Ultima handy to set up and enjoyable to use. It is convenient: for instance, your right hand falls straight onto the focuser knob when you reach for it. The top surface of the wedge makes a good table to park eyepieces or equipment not in use. And so on. What follows are our impressions of various operations and accessories involving the Ultima.

Polar alignment. Aligning the telescope and mounting on the pole are straightforward, although anyone who has never done it should not count on getting it perfect the first evening. (Perfect alignment isn't important for casual looking anyway.) The exercise consists of making a twofold adjustment. First, you raise the polar axis to the same elevation as the north celestial pole at the observing site. Second, you aim the polar axis due north in azimuth. (The wedge contains a small bubble level to establish the horizontal.) The polar axis elevation scale has divisions every 2°; this lets you set it roughly by eye, with "micro" adjustments made by means of a threaded rod that pushes against the bottom of the tilt plate and alters its angle to the horizon. You adjust the azimuthal aim by slightly loosening the three bolts that hold the wedge on the tripod. Then you turn another threaded rod until the aim is correct and retighten the bolts. You get about 20° of movement in azimuth.

The owner's manual, which covers other models of Schmidt-Cassegrains besides the Ultima, describes several methods of polar alignment ranging from the quick and dirty "aim the fork at Polaris" to the star-drift method, which is accurate though tedious. Illustrations are few, so read the descriptions over carefully until you understand them and practice the adjustments indoors first. Besides these methods, however, the Ultima also offers another way to get a polar alignment. It combines an illuminated reticle on the finder scope with a cardboard time-and-date computer that tells you Polaris' position relative to the real pole. The method is not as accurate as star drifting, but it gets you aligned in about three or four minutes — make that ten minutes the first time you do it.

Finder scope. The 8x50 finder scope comes with two back ends: one is an ordinary "straight-through" viewer, the other has a right-angle mirror with an illuminated reticle used for polar alignment. The brightness of the latter

is adjustable.

We found, however, that the on/off switch for the reticle's bulb was an invitation to a run-down battery or lost parts. You turn it off by partially unscrewing the cover of the battery compartment. This "switch" is difficult to use properly with fingers that are stiff from cold or in gloves. (Assembling it outdoors, we dropped the battery into four inches of powder snow and had to rummage for it barehanded at 10° F.) This design should be replaced with a safer, glove-operable switch.

Although the manual doesn't say so, you can pack the telescope into the carrying case with the finder and its mounting bracket attached. This is fortunate, because we found that removing the entire finder scope and bracket is an involved procedure, given that one of the two attachment bolts for the bracket lies directly under the finder scope itself and is inaccessible when the finder scope is in place.

Changing the finder scope from polar alignment mode (using the reticle) to the ordinary viewing mode may pose some difficulties. It requires the smallest Allen wrench provided, which is skinnier than a toothpick and easy to lose because it's black. You locate a tiny screw on the side of the mirror housing and loosen it slightly so you can remove the reticle-bulb-battery assembly. This is necessary for unscrewing the mirror housing from the back of the finder scope tube and replacing it with the ordinary eyepiece holder. We found it almost impossible to do this operation without nudging the finder scope slightly out of collimation with the main telescope.

Many observers find that cold weather and darkness don't mix well with fussy little movements involving tiny parts, because chilled fingers (and inexperienced ones) work at reduced efficiency. Be sure to practice setups with the Ultima indoors under good lighting before you work with it at the observing site in the dark.

Carrying case. The Ultima 8 arrives in three cardboard cartons. The biggest contains a black carrying case that holds the main scope and fork/drive assembly, together with accessories. The case measures 15 by 23 by 32 inches and weighs 55 pounds with the telescope and accessories packed inside. It appears to be made of plasticized fiber board, while the fittings are aluminum.

You undo the nonlockable snap catches, open the carrying case, and find the telescope and fork nestled in plastic foam. In the corners, the finder scope and other accessories fit into small cutouts in the foam. The foam ranges in thickness from one inch to several inches and appears sufficiently thick to protect the instrument from the routine bangs and thumps of ordinary handling.

On the other hand, we were disconcerted by certain aspects of the carrying case. Frankly, it seems cheap in comparison to the telescope itself. For example, the one and only carrying handle fastens on with four small rivets. One of us commented, "I never pick up the fully loaded case without wondering if the handle is going to rip away." The handle never did loosen or come off, but we still think it looks and feels much too flimsy to give the years of trouble-free service that the telescope itself will give.

Likewise, the carrying case walls seem too thin to protect the scope from serious impacts. What would happen, we wondered, if the loaded case fell off a tailgate on to the ground? Would the case provide enough protection for the telescope?

The loaded case, heavy and awkward as it is, can be carried by an adult of average strength, but he or she will not wish to carry it very far and will be greatly off-balance at every step. This is something to consider, as it may pose a problem with setting up in the dark at some observing sites. If the case were sturdier and had two strong handles, one at each end, in addition to the single one, two people could carry it easily and safely.

The tripod and wedge come in the other two cartons. Both are ordinary cardboard boxes that offer some protection during shipping but are clearly not intended for long-term use. After the shipping boxes give out, you will need to find a way to protect the tripod and wedge during transport if you wish to keep them looking new.

To sum up — and notwithstanding the quibbles — we found the Ultima to be a sound instrument that will give years of satisfactory use. In our view the Ultima's principal problems are shakiness in the mounting, the periodic error in the drive, and a carrying case that seems inadequate. If these few problems were ironed out, the scope would approach being the "ultimate" of its type and size. □

Ultima 8

8-inch f/10 Schmidt-Cassegrain telescope. Supplied with enhanced reflectivity coatings (on the mirrors) and antireflection coating (corrector plate), tripod, equatorial wedge, drive, drive corrector control paddle, 8x50 finder with illuminated reticle, 30mm Plossl and 7mm orthoscopic 1¼-inch eyepieces, mirror star diagonal, AC adaptor for charging batteries, Allen wrench set, carrying case.

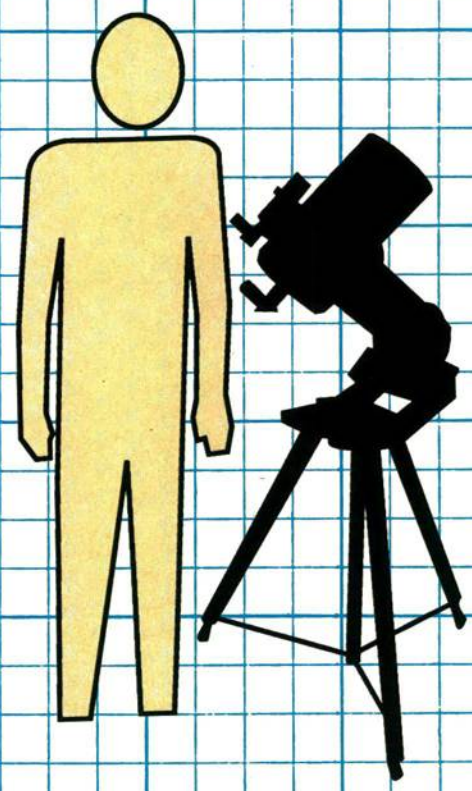
Manufacturer: Celestron International, 2835 Columbia Street, Torrance, California 90503; (213) 328-9560.

List price: $3,325.

Pros: Excellent images, self-contained power source for drive, heavy-duty fork, designed for astrophotography.

Cons: Shaky tripod, periodic error in drive, inadequate carrying case, some awkward design features.

Summary: A very good telescope of its type. Built-in power supply for drive gives owner flexibility in choosing an observing site. Byers drive acceptable for visual observations but problematic for guided astrophotography.



Get Ready for Pluto

This guide contains the finder charts and the best observing times for Pluto's brightest opposition of the century.
by Richard L. Talcott

Have you ever seen Pluto? The smallest and usually most distant planet is so faint that few people ever look for it, much less find it. This spring and summer, however, Pluto is as bright as it ever gets, and anyone who owns an 8-inch or larger telescope — or has a friend with one — has a good chance of seeing the elusive planet.

Pluto is relatively bright now because it is closer to the Sun this year than at any other time in its 248-year orbital period. Although the planet's closest approach occurs in early September, from our vantage point on Earth, Pluto is closer, brighter, and easier to see this spring and summer.

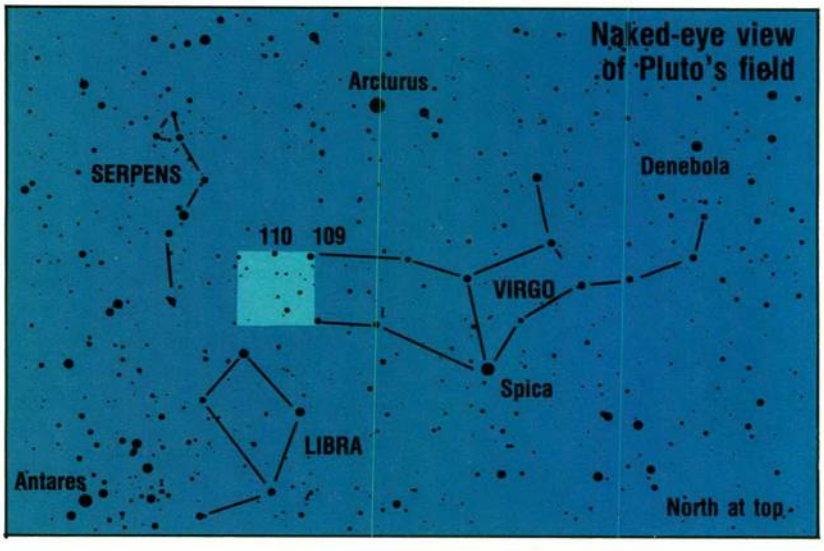
The ideal time to observe Pluto is in May. Pluto is at opposition — opposite the Sun in our sky — on the night of May 3/4. At that time Pluto rises at sunset, is highest in the sky around midnight, and sets at sunrise.

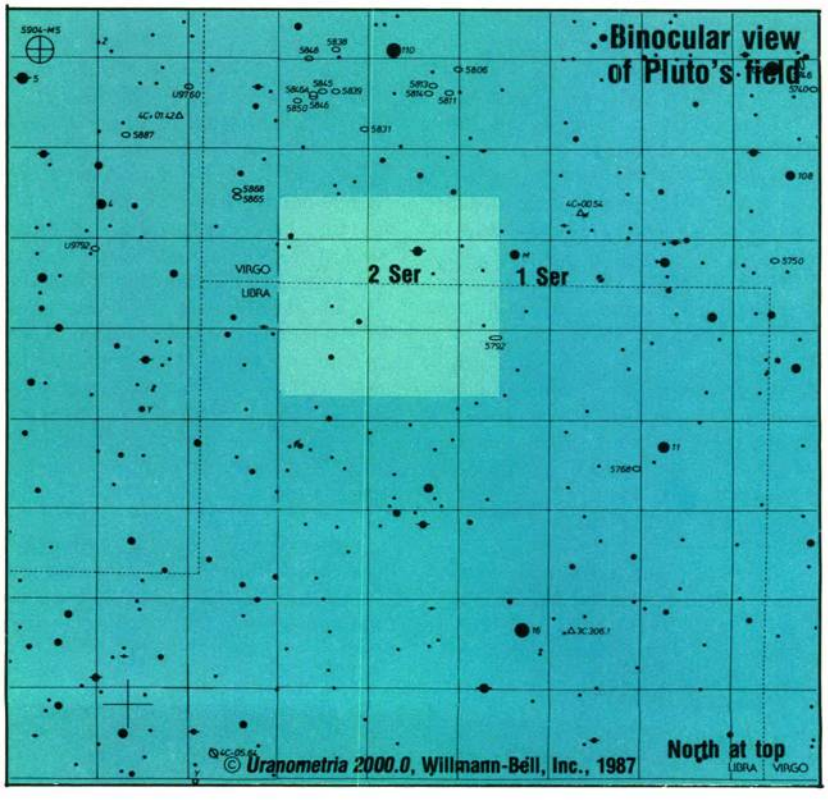
The Challenge of Pluto Hunting

Despite its comparative brightness this year, Pluto remains a challenging object. To see the 14th-magnitude speck of light, you'll need a telescope at least 8 inches in aperture, though a 10-inch or larger telescope makes the task much easier. If you don't have a telescope large enough, go Pluto hunting with a member of the local astronomy club. Remember that few observers, veteran or beginner, have seen Pluto before, and most of them would like to.

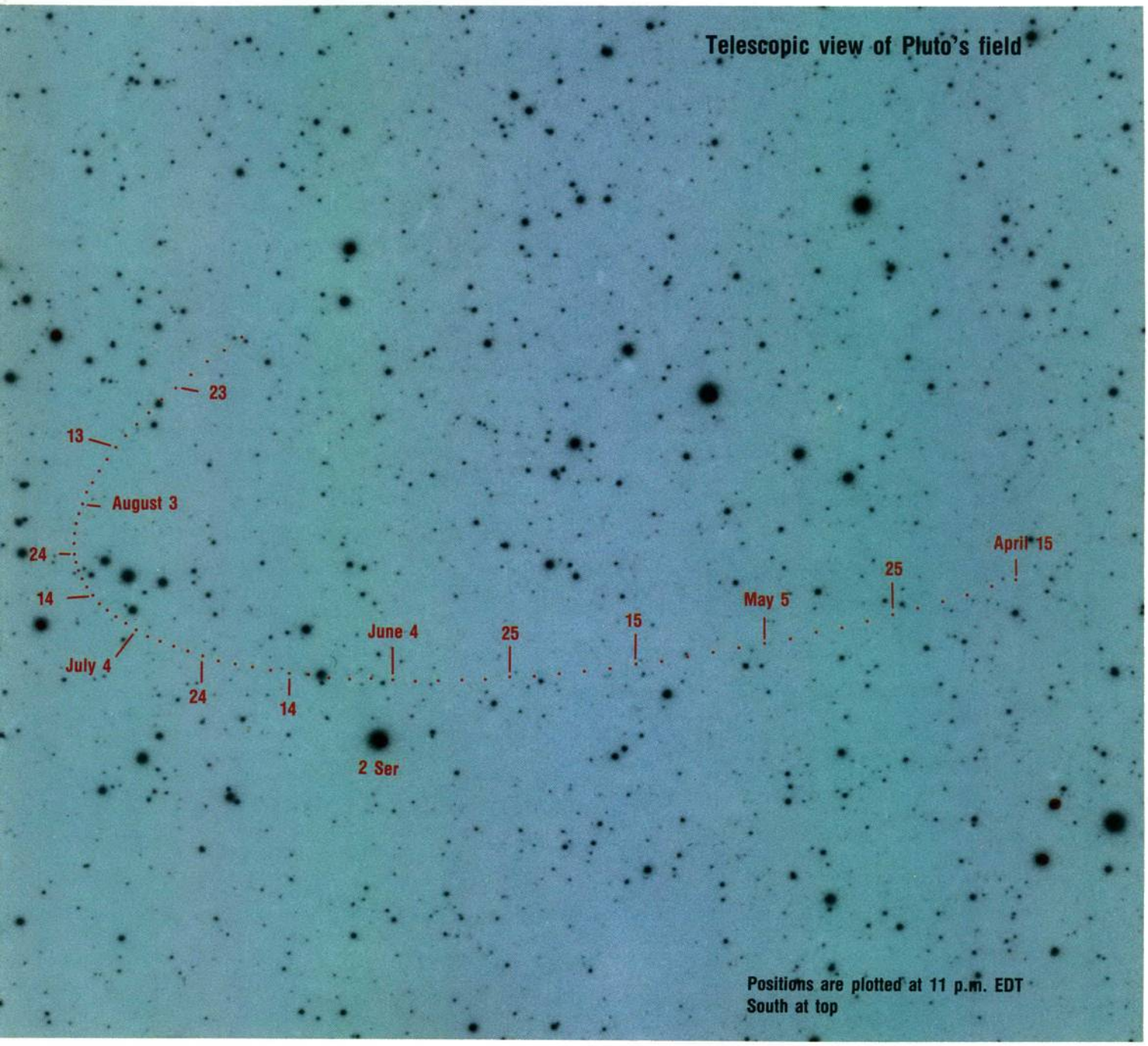
Once you've got a telescope lined up, you need a good observing site. For finding Pluto, this means a site with a dark sky and good seeing conditions. Avoid areas that absorb heat in the daytime and reradiate it at night — asphalt roads and parking lots are two notorious examples. Large, grassy fields or parks usually make excellent sites.

Finally, you need to search for Pluto at the right time. For the same reason you need a site far from city lights,





at Its Best


Telescopic view of Pluto's field
23
13
August 3
24
14
July 4
24
14
June 4
25
15
May 5
25
April 15
2 Ser
Positions are plotted at 11 p.m. EDT
South at top

MOON-FREE OBSERVING PERIODS

Date of New Moon	Hours of Moon-Free Observing	Good Observing Window
May 5	6½	April 24-May 12
June 3	5¼	May 24-June 12
July 3	4¾	June 26-July 12
August 1	3¼	July 26-August 9
August 31	2¼	August 24-September 5

The best time to search for Pluto is near New Moon, when the Moon is out of the sky all night and Pluto is visible if it is above the horizon. At the beginning and end of each "good observing window" there are at least two hours in which to find the planet while the Moon is out of the sky.

PLUTO-CHARON MUTUAL EVENTS

Date	Begin	Maximum	End	Magnitude
*April 17	5:16 a.m.	7:03 a.m.	8:50 a.m.	0.19
April 30	11:51 p.m.	1:41 a.m.	3:26 a.m.	0.19
June 1	10:21 p.m.	12:14 a.m.	2:16 a.m.	0.26
July 2	8:53 p.m.	10:43 p.m.	12:55 a.m.	0.34
*July 22	12:46 a.m.	2:35 a.m.	4:49 a.m.	0.36
August 3	7:20 p.m.	9:09 p.m.	11:23 p.m.	0.36
*August 23	11:10 p.m.	1:01 a.m.	3:11 a.m.	0.33

*Indicates some interference from moonlight

The table lists all inferior events visible from much of North America that the Moon does not totally obscure. Date: Date of maximum depth of event in eastern daylight time. Begin: Beginning of event in EDT; red indicates time on previous day. Maximum: EDT of maximum depth of event. End: End of event in EDT; red indicates time on next day. Magnitude: Magnitude drop in blue light at maximum depth of event. To convert eastern daylight time to your time zone, subtract 1 hour for CDT, 2 hours for MDT, 3 hours for PDT, 4 hours for Alaska, and 5 hours for Hawaii.

you'll want a night when the Moon is out of the sky. Use the table above to plan your observations for the dark of the Moon.

Homing In on Pluto

When the night to search for Pluto has come, your preparations will pay off. Arrive at your site early and set up your telescope right away so it can begin cooling to the air temperature. In the hour or so it takes the scope to stabilize thermally, your eyes will have become fully dark-adapted.

Once you can spot 6th-magnitude stars with your naked eye, you're ready to track down Pluto. Begin by finding the bright stars Arcturus and Spica. Arcturus is a zero-magnitude, orange-tinged star located high in the south late on May evenings, and Spica is the 1st-magnitude luminary of Virgo located about 30° south and 13° west of Arcturus. (See the map at the top of page 84.)

Locate Pluto by "star hopping" from Spica. First, move about 14° east-northeast to the 4th-magnitude star Iota (ι) Virginis, and from there move 11° northeast to another 4th-magnitude star, 109 Virginis. Four degrees due east of that star lies 4th-magnitude 110 Virginis. (See the map at the bottom of page 84.)

Using binoculars or your finder scope, drop just over 2° directly south to the 6th-magnitude star 2 Serpentis (which is now located in eastern Virgo). This is the key star in your quest for Pluto this year because it is fairly bright and lies within approximately 1° of Pluto throughout the prime observing period.

You're now ready for the final push. Using the detailed finder chart on page 85, star hop from 2 Serpentis to Pluto's position on the date you're observing. The positions plotted are for 11 p.m. EDT (10 p.m. CDT, 9 p.m. MDT, and 8 p.m. PDT) on the date indicated. (To find the planet's position on a date not plotted, interpolate between the two closest dates.)

When you look at Pluto's field in the telescope's eyepiece, you'll probably be surprised by the number of stars visible. To reduce the confusion, center Pluto's position in a low-power eyepiece and increase the magnification until you are using at least 10x per inch of aperture. That gives you a reasonably uncluttered field to make the final identification.

By comparing the detailed finder chart with your eyepiece view, you should be able to discern the dot of light that is Pluto. But to be absolutely sure you've pinpointed Pluto, make an accurate sketch of the high-power telescopic field. Observe the same field a night or two later and sketch the region again. When you compare the second sketch with the first sketch, one of the "stars" will have changed position relative to the others. That 14th-magnitude speck is Pluto.

Pluto and Charon

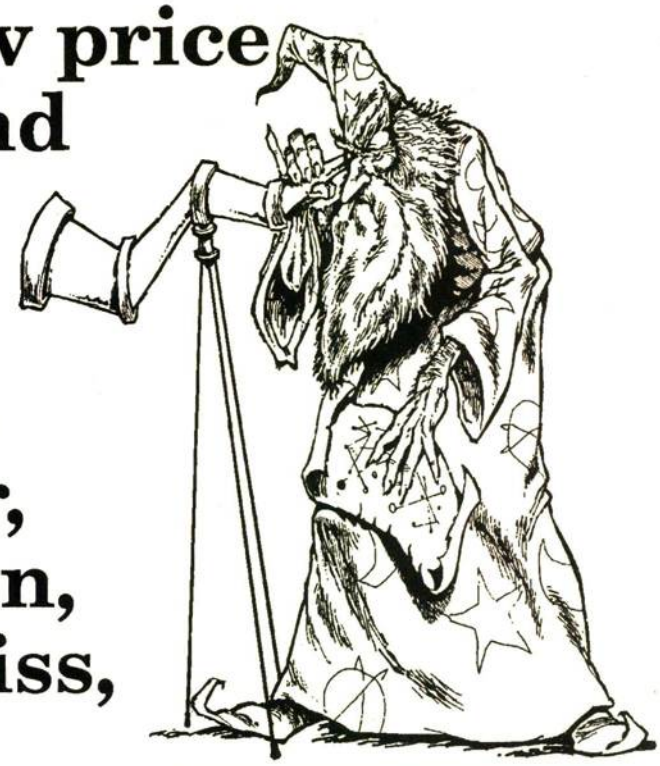
If you're an old hand at observing Pluto or become one during the summer, you might try to observe some of the mutual eclipses, occultations, and transits between Pluto and its natural satellite, Charon. (See "How to View This Summer's Pluto-Charon Transits" by David J. Eicher, May 1987.) The current series of events ends next year and won't be repeated until the twenty-second century, so this is one of the last opportunities you'll ever have to witness the rare events.

The table above lists the time and magnitude drop of each inferior event — when Charon passes in front of Pluto — visible from North America during this observing season. The change in magnitude is fairly easy to detect with a photometer or photographic techniques, but seeing the event visually requires a trained eye and careful comparison of Pluto's light to that of nearby stars.

Finding Pluto is a challenge not meant for everyone. But if you have the desire, make the preparations, and persevere to the end, you have an excellent chance of viewing the elusive planet this year. Although the point of light shines faintly at best, the glow you'll feel after seeing Pluto can last a lifetime. □

Looking for a low price on a telescope and accessories . . .

from Celestron, Meade, Edmund, TeleVue, Questar, DayStar, Lumicon, Vernonscope, Zeiss, Leitz, and more?



Call us.

We'll meet or beat any price in this magazine.

Now for the not-so-fine print . . .

1.- The product has to be a fully-equipped current model.

2.- The price must be advertised elsewhere in this magazine.

3.- The price has to include freight.

We're authorized dealers for all the brands listed above, plus Bushnell, Bausch & Lomb, Swarovski, Kowa, Swift, University Optics, and more – all factory-fresh, with every accessory the manufacturers' supply, and all with full factory warranties. We don't sell grey market imports with no U.S. warranty. If we have it in stock, we'll do our best to sell it to you for less money than the competition – without sacrificing the good service and honest advice we're known for. We're not a New York camera store and we won't treat you like one.

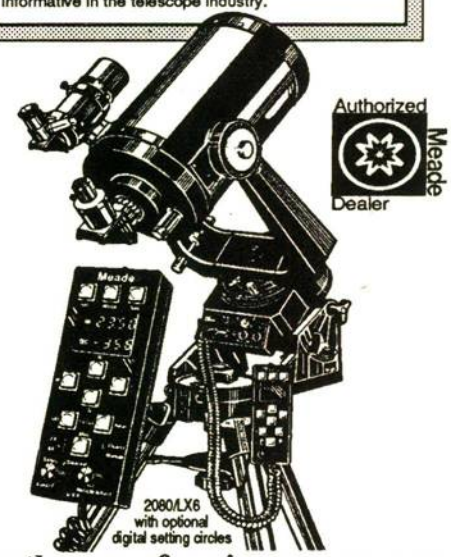
In stock for immediate shipment – the Meade 2080/LX6 and 2120/LX6. Fast f/6.3 focal ratios make short work of deep space astrophotography. Complete with wedge; tripod; AC, DC, and penlight battery power supplies; hand control; 9 x 60mm illuminated finder; 2" star diagonal; 26mm Super Plossl eyepiece; many more features and accessories. Can use optional digital setting circles with accuracy 25x better than ordinary setting circles, or Meade CAT system that leads you to 8,199 deep space objects and the planets! Meade digital circles and CAT system also available for other scopes. Call for pricing.

FREE FREIGHT
(EXCEPT ON CREDIT CARD SALES)

Some dealers advertise low prices, but sock it to you on the freight. We don't do that. Our prices include *free* insured UPS shipment within the 48 continental United States if you pay by check or money order. Add 3% freight if payment is by credit card ($2 minimum freight charge).

***WRITE* FOR FREE DISCOUNT PRICE LIST**

Send a stamped (45¢ postage), self-addressed business-size envelope for our free discount price list, unadvertised specials list, and information about how to pick the right telescope. Or, send $2 (refundable with your first order) and a *large* stamped ($1.05 postage), self-addressed envelope for our full 64-page, 40,000 word catalog that describes the more than 80 telescopes, 70 binoculars, and 600 different accessories that we carry. Even our competitors admit it's the most informative in the telescope industry.



ad-libs
astronomics
Our tenth year of saving you money.

2401 Tee Circle, Suites 105/106, Norman, OK 73069

Toll-Free Order Line: **(800) 422-7876** Tech Questions/Customer Service: **(405) 364-0858**

Use (800) 422-7876 for price quotes and credit card orders only. Use (405) 364-0858 for technical advice and all calls from AK, HI, and OK.

Hours: Monday thru Friday, 10:00 AM to 5:30 PM CST. **Mastercard, Visa, Discover, Optima, and American Express.**

Freight extra on credit card, Canadian, AK, HI, APO, and orders shipped by air. $2 service charge on orders under $25. $5 per carton COD charge. U.S./Canadian sales only.

ENJOY ASTRONOMY AT DOWN TO EARTH PRICES

$18 VALUE FREE $18 VALUE
focus ASTROPACK
- Guide to Astronomy
- Astrophotography Basics by Kodak
- Professional Optical Maintenance Kit

w/Purchase of Any Telescope

focus CAMERA INC.

4419-21 13th AVE.
BROOKLYN, N.Y. 11219

FOR ORDERS ONLY
CALL TOLL FREE
800-221-0828
INFORMATION 718-436-6262

Ask for **HELEN, NEIL** or **MARK**, our **TELESCOPE EXPERTS**

FOCUS CAMERA has been serving customers nationwide with all their photographic & astronomical needs for over 18 years. We invite you to join our thousands of satisfied customers. Call our knowledgeable sales staff **TODAY!** and **SAVE!!**

SATISFACTION GUARANTEE: Refund or Exchange within 14 days (less shipping) if returned in original **MINT CONDITION** intact with all papers as shipped.

Meade® TELESCOPES & ACCESSORIES

Authorized Dealer — THE LEADER'S EDGE

LATEST MODEL

2080 SERIES SCHMIDT-CASSEGRAIN TELESCOPES

2080 LX3

- Best Seller Astronomical Telescope for the Serious Amateur
- **Quartz Electronic LX3 Drive**
- Tremendous Light Gathering Capacity
- **Multi Coated Optics Group**
- **AC** or **DC** Operation
- Supplied w/Ultra-Precise Drive System to Automatically Track Astronomical Objects

Complete Factory Pack Includes:
Wedge & Tripod, Star Diagonal, Visual-Back, **8x50** Finderscope, 25mm 1-1/4" Eyepiece, Trunk Case **$1244.95**

2120 LX3 10" As Above w/#36 Controller **$1639.95**
2080 8" Telescope w/**High Trans. Coating** 889
2080 LX5 NEW! w/2" Visual Back DC Oper. North/South Operation ..... **CALL**
2120 LX5 10" Same As Above *SPECIAL LOW PRICE* **$1859**

THE LX6 REVOLUTION ARRIVES!

- Fast **F/6.3 Schmidt-Cassegrain** • **59% Wider** Field of View
- **60%** Less Photo Exposure Times
- Digital Readout Capability (Option)

2080 LX6 8" 1280 mm F/6.3 Complete Outfit **$1827**
2120 LX6 10" 1600 mm F/6.3 Complete Outfit **$2398**
Digital Readout Option 319.95

ACCESSORIES FOR LX3, LX5, LX6

#36 Hand Control (LX3) **Special** 81
#38 DEC Motor (LX3) ..... 78 — **#39** DEC Motor (LX5,6) 91
#1200 FOC MTR (LX3) ..... 139 — **#1200A** Foc. Mtr (LX5,6) 159
#1401 Tube Blnc. 8" ..... 82 — **#1402** Tube Blnc. 10" 87

Meade CAT Computer Aided Telescope System ..... **CALL**
DSC Digital Setting Circles f/8" & 10" LX3 & LX5 ..... **CALL**

Meade REFRACTORS

#226 2.4" Beginners Scope 147.95
#312 3-1" Altazimuth **900 mm f/11** Complete Outfit w/**Tripod** **$429.95**
#323 3-1" **Equatorial** 900 mm f/11 Complete Outfit w/**Tripod** **$479.95**
Camera Adapter ..... 38 — **45°** Erect Image 48.95

MTS TELESCOPE SALE

Meade's Sophisticated Modular Telescope System Allows You to Customize Your Scope To Your Individual Requirements.

SN Schmidt Newtonian — **SC** Schmidt Cassegrain

ALL MTS Scopes Include Pier Mount, 25 mm EP
SC Include Finderscopes, SN Include Focusers

	Basic Scope	w/788 Drive	w/LX3 Drive
SN6	528	597	759
SN6-MCOG	577	649	809
SN8	699	765	925
SN8 MCOG	759	817	975
SC8	CALL	915	CALL
SC8 MCOG	CALL	965	CALL
SC10	1329	1449	1679

FREE **Meade #109** Setting Circles (49.95 value) w/Scope & Drive

#788 Drive ..... 117 — LX3 Drive 329
#66A DEC. Arm ..... 43 — **#66C** DEC. Arm 55
#38M Electric DEC. System 85
#36 Hand Control ..... 81 — **#1401** TB Bal 82
6x30 Finder ..... 37 — 8x50 Finder 57

DEEP-SPACE TELESCOPES

DS-10A 10" f4.5 Ultra-Sharp Reflecting Telescope w/Motor Drive, Setting Circles and Deluxe Focuser **$818**
DS-16A 16" Reflector. Gathers 4 Times as Much Light as an 8" Scope! Includes Motor Drive, Focuser & 1¼" Eyepiece **$1679**

Meade SPOTTING SCOPES

LIFETIME WARRANTY

A WHOLE LOT MORE THAN MEETS THE EYE!

97E-II Erect Image Spotting Scope, **Great Value!**
- 3.5" 1000 mm f/11 Meade Optics
- 5x21 Erect Image Finder
- 45° Erect Image Diagonal
- 40x Eyepiece • Focusing Scale

4-Pc Complete Outfit **$319.95**

97ER-II Same as 97E-11 w/Rubber Coatings **$375**
Hard Case ..... — Lens Shade 39

PATHFINDER II 15-60x Razar Sharp Compact Spotter **$195**

ACCESSORIES & EYEPIECES:
We Have **Huge** Stocks of Meade Eyepieces & Accessories.
CALL **Helen** For a **Great Deal**

CELESTRON®

POWERSTAR 4

8x50 Polar Illuminated Finder
30 mm Plössl & 7 mm Ortho Eyepieces
T-Adapter, Piggyback, **Dew Shields**
Foam Fitted Case, **Wedge & Tripod**
Factory Package ..... **CALL**

POWERSTAR 3 Limited Supply **$1459**
ULTIMA 8 8" Rugged Design Quartz Drive ..... **CALL**
CLASSIC 8 **The Classic 8" Schmidt-Cassegrain Telescope Returns**
- 8" 2032 mm f/10 High Quality Optics
- Spur Gear Motor Drive
- **High Transmission Coatings** ..... **CALL**

Complete Outfit Includes:
6x30 Finder, Star Diagonal, Wedge
25 mm Multicoated Kellner Eyepiece
CLASSIC 8 Starbright ..... CALL
Celestron Field Tripod 194

SUPER POLARIS C8 11-Piece Outfit w/Tripod, Limited! **$1029**
SPC8 STARBRIGHT As Above ..... **CALL**
C-11 STARBRIGHT ..... **CALL**

NEW MODEL

FIRSTSCOPE 80 6-Piece Outfit
80mm Ultra-Sharp Optics
910mm Focal Length, Complete w/50X Eyepiece, **45° Erect Image** Diagonal Alt-Azimuth Mount w/Slow Motion Controls, Field Tripod w/Tray **$469.95**

SPC-102 1000 mm Equatorial Super Polaris Mount ..... **CALL**

NEW

C90 SPOTTING SCOPES

- 3-5" 1000 mm f/11 Optics
- Can Be Used as a Spotter or Tele Lens
- 8x20 Erect Image Finder
- 45° Erect Image Diagonal
- 30 mm (33x) E.P. • Hard Case

C90 BASIC Basic Spotter Great Value **$353**
C90 MC w/Multi-Coatings
C90 R/C Rubber Covered Scope & Rugged Design **$407**
C90 R/C MC As Above w/Multi-Coat
Super C90 Conversion Kit (f/11¼ & Acces.) ..... CALL
Zoom Eyepiece ..... 88 — • 96° Ortho EP 39
• 96° Kellner E.P. ..... 30 — 2x Barlow 19
3x Barlow ..... 30 — T-Adapter 28
Lens Shade ..... 48 — Sky Filt. #1 33

C65 2.5" Maksutov Spotting Scope Rubber Covered **Compact** **$203**
SS80 3.1" 400 mm f/5 Wide Field Multicoated Refractor **$319**
SS-50 2" Spotter Special 75
ZOOMMASTER II 15-60x Zoom Rubber Coated **$298**
Lightweight Tripod 79
Celestron Photo Tripod 114
C4.5 NEW 4.5" Newtonian w/Equatorial Mount **$439**

ACCESSORIES

Barlow **2X, 3X** 1¼ ..... @ 38 — LPR #3, 4 ..... @ 67
Counterweight Bar ASS. 8" 92 — Porro Prism 1¼ 43
Dewstar/Shield 8" ..... 23 — Rich Field Lens 28
EP Filter Set 1¼" ..... 75 — Sky Maps 14
Illum Reticle 1¼" ..... 142 — Sky Filter #2 (C8) 36
Image Corrector 1¼" ..... 38 — Tele Extender 28

This is a small selection. Please **Call** For **Eyepieces** or other accessories.

BAUSCH & LOMB

CRITERION 3000 TELESCOPE SPOTTING SCOPE/TELEPHOTO

"THREE-IN-ONE OPTICAL WONDER"
3.1" f/10 Malkutosov Cassegrain Telescope or 800mm f/10 Spotting Scope or 800mm f/10 Telephoto Lens
Complete with 25X, 40X Eyepieces
Prism Diagonal & System Case **$179**

CRITERION 8000

- 8" Schmidt Cassegrain Telescope — 2-Pieces
- Clock Drive • 8x50 Finderscope — In Stock ..... **CALL**

BANNER ASTRO 280

60 mm Altazimuth Refractor w/3 Eyepieces, 2x Barlow, Tripod **$129.95**

BAUSCH & LOMB Discoverer Zoom Telescope

Spotting Scope w/15X-60X Zoom 189
Camera Mount ..... **14.95** — Case 20
Car Window Mount ..... **CALL** — Tripod 59

SPACEMASTER®

PRISMATIC TELESCOPES — **4-PC. OUTFIT**
- SPACEMASTER 60MM
- 15-45X Zoom Eyepiece
- Mini Tripo
- Deluxe Backpack Case

Spacemaster $212 — **Spacemaster II $218**

SPACEMASTER #1800 ..... 119 — Camera Mount 32
Eyepiece ..... **35** — Zoom ..... **83** — Wide-Angle 42
#2300 **45°** SPACEMASTER ..... 178 — Case 19

GIANT BINOCULARS

CELESTRON® UNITRON® Meade

- Perfect for Astronomy & Low Light Viewing
- Glare-Free Viewing & No Eyestrain
- Exceptional Image • 25 Yr. Warranty

11x80 ..... **228** — 20x80 ..... **239**
Multicoated ..... **CALL**
16x70 Astro Observation 323

20x80 DELUXE Multicoat w/Sliding Rail **$469**
11x80R **Rubberized** ..... **CALL** — 20x80R **Rubberized** ..... **CALL**
Tripod Adapter 18.90

SPOTTING SCOPES & BINOCULARS

Nikon *The Famous Nikon Optics Are Your Best Assurance For Clear And Crisp Images*

NIKON SPOTTING SCOPE ED 509
Nikon Spotting Scope **ED** ..... **CALL**
Photo Attachment 114
7x50 Center Focus 'Starview' 146
7x35 CF w/25 Yr. Warr. 79
7x50 Tropical ..... **CALL** — 10x70-IF 378
8x23-CF ..... **135** — 10x50 Sentinal ..... **159** — 12x36D 227

Bushnell BINOCULARS

DISCOVERER
7x35 CF #61-2010 ..... **229**
10x50 CF Standard **289**
7x24 ..... **209** — 8x24 ..... **CALL**

BANNER SERIES:
7x50 Instafocus 74
10x50 Wide 77
8-24x50 Instafocus Zoom 136

EXPLORER SERIES:
7x50 Insta-Focus **114**
8x40 Wide Angle **114**
10x50 Wide **119**

SPORTSVIEW:
7x35 Extra Wide Angle **52**
7x50 ..... **59** — 10x50 ..... **61**
8x40 Wide ..... **61** — 16x50 ..... **72**

JIM'S MOBILE INDUSTRIES

"UNSURPASSED IN FUNCTION FEATURES & DESIGN"

MotoFocus:
- Finest Quality Electric Focuser
- Built-in Variable Speed Control
- Easy to Install **$78**

Available For **Meade:** 2080/2120, LX3, 5, 6
Celestron: C5/C8/C11/C14

MotoDEC:
- **Finest** Dec. Motor For Your **Meade**
- **Direct Drive** No Gears to Damage
- Friction Clutch • **Variable Speed**

For Meade 2080/2120, LX3
LX5, LX6, MTS (w/Dec Arm) **$75**

LCD Timer
- Attaches to Your Hand Control
- Time Exposures with Ease • Audible Alarm **$21.95**

TELE VUE

GENESIS 4" f/5 APO Fluorite Equtorial Refractor ..... **CALL**
ORACLE 3" f/7.4 APO Triplet Altazimuth Refractor ..... **CALL**
Tele Vue Eyepieces ..... **CALL**

VISITING NEW YORK?

Come to Focus Camera in Brooklyn
Meet Our Knowledgeable Salesmen AVI & Alfred.

focus CAMERA

4421 -13th Ave.
Brooklyn, N.Y. 11219
ORDERS: 800-221-0828
INFORMATION: 718-436-6262
CUST. SERVICE: 718-871-7608

Orders Shipped Promptly—Mastercard, Visa & **Discover** gladly accepted. You may use your American Express card. No surcharge on Mastercard, Visa or **Discover.** Please add estimated charge for shipping, handling & insurance. Written inquiries welcome. Not responsible for typographical errors. HOURS: Mon-Thurs 10-7, Fri 10-4, Sun 10-6. All merchandise available at prices shown while supplies last. This ad supercedes all other ads.

All Telescopes Include Full U.S.A. Warranty, and are Shipped Complete as Packaged by the Manufacturer.

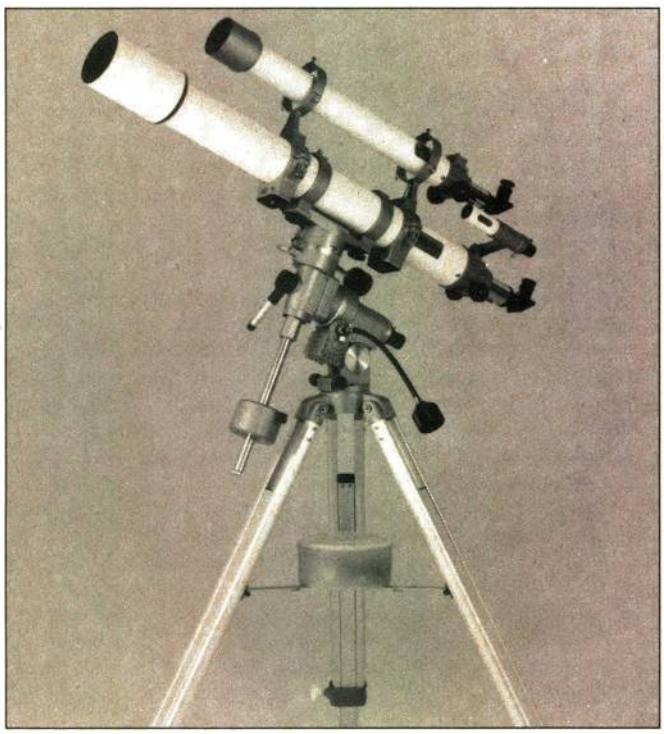
USA SPORT OPTICS

The largest and most prestigious
manufacturer and supplier of quality optics in Japan,
Vixen Optical Industries, Ltd.,
comes to the U.S. directly via USA Sport Optics!
Vixen has been awarded the "Grade-A" rating
by the Japan Consumer's Association.

Premium optical quality. . . Extensive product offerings. . . Prompt delivery

• Telescopes • Binoculars • Spotting Scopes • Microscopes

Many models to choose from Send $1.00 for complete catalog and introductory specials.

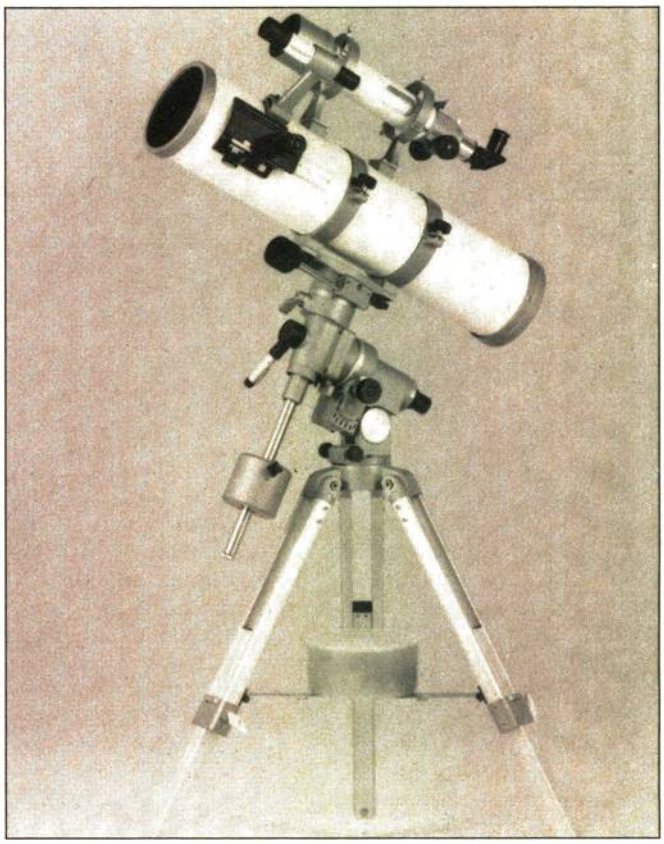


#3326 A large 90mm achromatic refractor (1000mm fl, f11.1) with the world famous Super Polaris equatorial mount with built-in polar alignment device. Pictured with optional guidescope.

Normal price: $895 **Special introductory price: $799**

#3327 (Not pictured) 90mm Fluorite (810mm fl, f9) with Super Polaris mount.

Normal price: $1995 **Special introductory price: $1799**



#3226 6" Newtonian Reflector (720mm fl, f5.5) with the Super Polaris mount. Pictured with optional guidescope.

Normal price: $895 **Special introductory price: $799**

#9831 Giant Binoculars — 25x125. Achromatic objective lens — 2° field of view. Straight through. Write for pricing.

#9832 Same as above — 45° angle.

Normal price: $2495
Special introductory price: $2299

Send $1.00 for catalog and introductory specials:

USA SPORT OPTICS

P.O. Box 8015-304
Redondo Beach, CA 90277

Name_____

Address_____ **Apt.**_____

City_____ **State**_____ **Zip**_____

AS

Dramatically Diverse Globulars

Even in a small telescope you'll find that globular clusters come in a variety of sizes, densities, and brightnesses.
by Chris Schur

Globular clusters are all alike — every single one is nothing more than a dim, fuzzy ball of light!" I can't keep count of how many times I've heard someone say that at a star party. Yet it couldn't be farther from the truth. Globular star clusters offer great variety for amateur astronomers. Anyone with a small telescope and a sharp, patient eye can see rich details in just several nights of globular hunting.

Globular clusters are unique, ancient pieces of the Galaxy. Massive spheres of stars, they reside in the Milky Way's halo, far from the galactic disk. Astronomers believe globulars formed at the same time as the rest of the Galaxy but for unknown reasons didn't succumb to the gravitational tug of the developing galactic disk. Instead, they remained independent of the Galaxy, orbiting it like bees around a hive. Their orbits periodically carry them through the galactic plane, sweeping them free of gas and dust necessary for star birth, sterilizing them. Therefore, globular clusters contain old, cool, slow-burning stars that softly glow in shades of yellow and orange. These stars are pristine links to the Galaxy's ancient past.

One of the best places to see these stars is in **M13** (NGC 6205), the Hercules Cluster. Although several globulars are larger and brighter than M13, the Hercules Cluster is unrivaled for viewers in the north because it rises high in the sky. Located at +36° declination, glowing at magnitude 5.9, and measuring 16.6′ across, M13 is barely visible to the naked eye on dark nights. It appears like a 6th-magnitude star on the western side of Hercules' distinctive "Keystone" asterism.

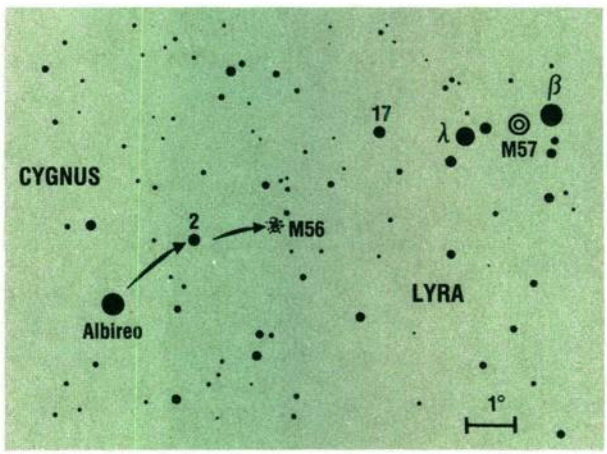
To find M13, aim your telescope at the 4th-magnitude double star Eta (η) Herculis, the northwest corner of the Keystone. Move the scope 2.5° to the south and you will see M13 as a small, fuzzy "star" with a brighter center. The cluster forms a compact isosceles triangle (20′ on a side) with two 7th-magnitude stars, one positioned south of the cluster and the other to the east. Several dozen fainter stars lie scattered uniformly within 2° of the cluster.

The smallest telescopes and binoculars portray M13 as a tiny round disk devoid of stars. Its gray-green glow betrays a star but fails to display cluster stars, which gives the impression of a washed-out planet. However, the cluster's appearance dramatically changes given a few more inches of aperture.

On nights when the atmosphere is steady, a 4-inch telescope at moderate powers shows a few of the brightest stars near the cluster's edges, red giants that glow feebly at 11th magnitude. The overall view is that of a glowing ball of light with an intense center and a mottled appearance at the edges. During moments of good seeing the atmosphere permits light from the brightest stars to pass and you can see these stars as distinct points of light. A 4-inch scope is generally the smallest that reliably shows M13 as a cluster of stars, not just a nebulous glow.

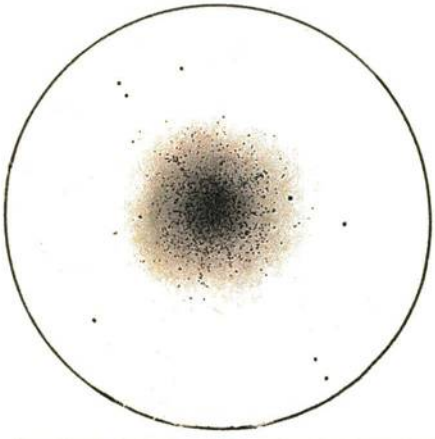
Larger apertures provide a stunning view of the Her-

M56
Magnitude 8.3 Size 7.1′ by Lee C. Coombs



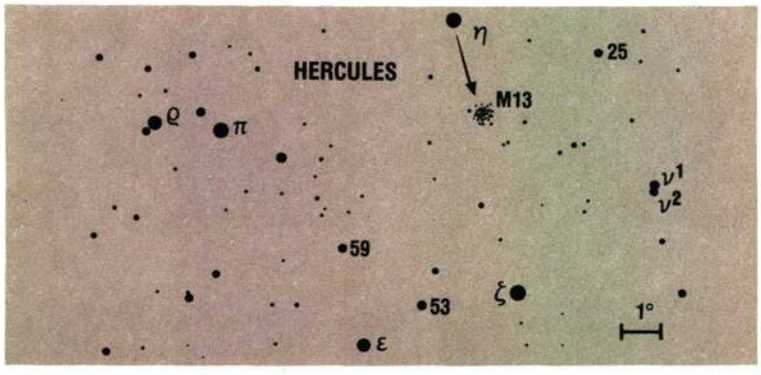
TINY, CONDENSED M56 lies in the constellation Lyra in a rich field of stars. To find it, star hop from Albireo to 2 Cygni and on to the cluster.

M13
Magnitude 5.9 Size 16.6′ by Jack Newton



M13
8-inch f/10 SCT at 100x

THE GREATEST GLOBULAR of the northern sky, M13 in Hercules is easily resolved in small telescopes; large scopes show lanes of stars winding away from its center. It lies on the western side of Hercules' Keystone asterism.

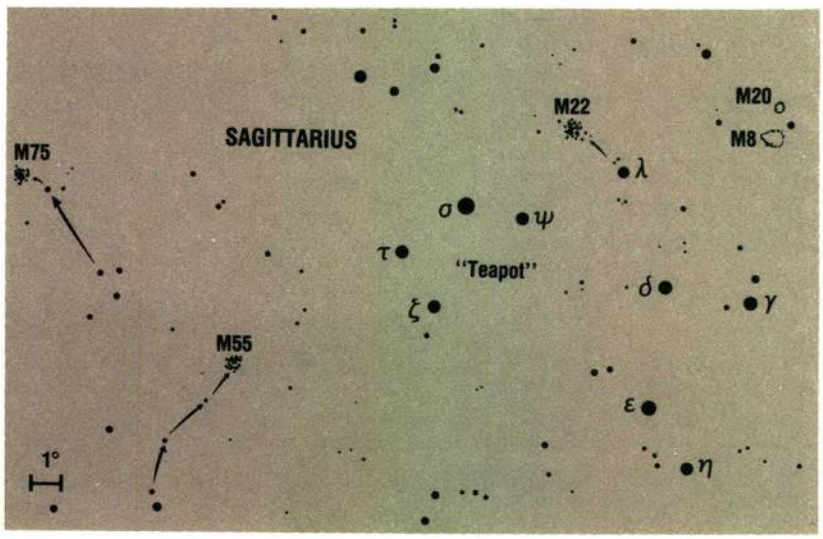


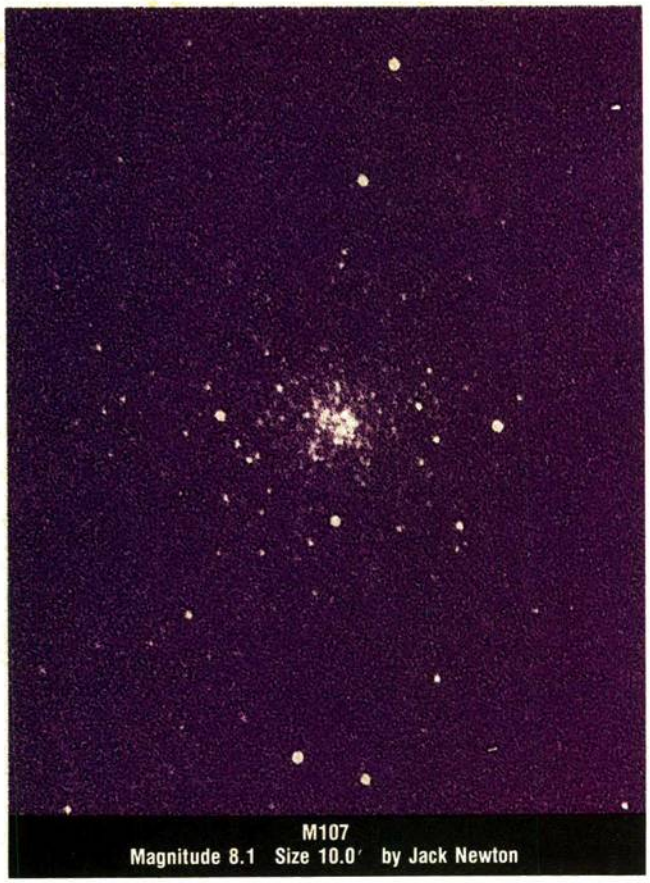
M22
Magnitude 5.1 Size 24.0′ by Scott Hicks

M55
Magnitude 7.0 by Martin Germano

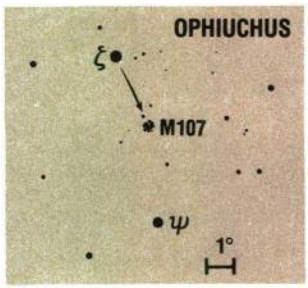
M75
Magnitude 8.6 by Jack Newton

RICH, LOOSE M22 is the finest cluster in Sagittarius. Individual stars in M22 are visible even with a 4-inch telescope. Even less condensed is M55, visible as a faint cloud of light in small scopes. In marked contrast, nearby M75 is a bright, condensed ball of light that is difficult to resolve into stars.





M107
Magnitude 8.1 Size 10.0′ by Jack Newton



A TINY KNOT of stars, M107 in Ophiuchus can be found by star hopping from Zeta Ophiuchi south to a triangle of three dim stars. The cluster lies immediately to the south.

cules Cluster. An 8-inch scope at 100x shows a field gleaming with stars: the big, hazy ball of light appears almost three-dimensional because of a spray of tiny stars that covers it.

In a 16-inch or 18-inch telescope the density of resolved stars grows from a few dozen encircling the cluster's edges to layers of hundreds of star points converging on the cluster's bright, central, yellow glow. At high powers the stars are too numerous to count, and undoubtedly many of the faint stars spilling out of a single field, scattered several arcminutes in every direction, belong to the cluster. The view is one that a photograph simply can't duplicate.

A few tricks of the trade can help you see more when you observe M13 and other globular clusters. Generally, high powers help to resolve the tiny, faint stars in globulars. However, don't use a magnification that is too high, or you'll simply get mushy, bloated star images. A crisp, low-power view beats a soft, high-power view. Try using 100x to 150x, and if you can't resolve the cluster, try again later when the atmosphere may be steadier. Magnifications much in excess of 200x normally only magnify atmospheric turbulence.

A combination of averted vision — glancing toward the side of the telescope's field — and very slowly sweeping the telescope side to side helps reveal faint details in clusters. This technique works because the eye's faint light receptors are acutely sensitive to motion. For example, this technique shows an extremely bright, condensed, ball-like center in the Hercules Cluster. Used with a large telescope, sweeping and averted vision reveal apparent dark "voids" and long streamers of stars that wind away from the center of M13 like spidery legs.

Field sweeping also helps in spotting **M56** (NGC 6779), located east of Hercules in the small constellation Lyra. Unlike M13, M56 lies in a rich starfield and is a small, condensed globular that is difficult to resolve because its stars are faint and tightly packed together. To locate M56, aim your finder scope midway between Gamma (γ) Lyrae and Albireo, the star that marks the base of the cross in Cygnus. There you'll see a close pair of 6th- and 9th-magnitude stars. Visible in finders as a small patch of nebulous light, M56 lies 1° southeast of this pair.

The stars in M56 together glow at magnitude 8.3 and are tightly packed into a diameter of only 7.1′ — less than half the size of M13. By contrast, M56 is much harder to resolve into stars. Once you've located the cluster, switch to moderately high power (15x per inch of telescope aperture) and slowly sweep back and forth over the cluster. With a 6-inch telescope you'll see a disk of gray-green light encircling a slightly brighter center, set in a field splattered with dozens of faint stars. The view of M56 changes little with increased aperture. The largest backyard telescopes, those in the 16-inch or larger range, resolve some of the cluster's stars on nights of steady seeing.

Follow the Milky Way south to find a dramatic contrast to M56, Sagitta's **M71** (NGC 6838). This cluster is one of the richest globulars visible in small telescopes and is partly resolvable in a 6-inch telescope. In fact, its stars are so loosely assembled that for years some astronomers proposed that M71 may be an exceedingly rich open star cluster.

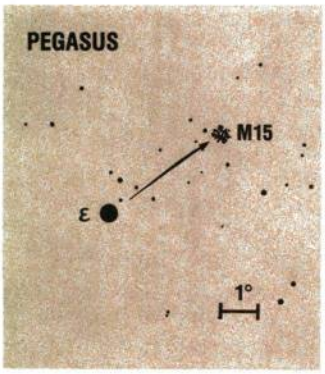
To find M71, start from Zeta (ζ) Sagittae, a bright star in the center of the constellation's distinctive arrow-shaped asterism. Star hop 1.5° east-southeast and you'll arrive at a rich field containing a 6th-magnitude double star and M71. (The loose open cluster Harvard 20 lies just south of this field.)

Telescopically M71 is a delight. The cluster's magnitude and size are virtually identical to those of M56, but M71 offers a far better view. A 4-inch scope at high power resolves a few of the group's brightest stars around the edges. Six-inch telescopes reveal that M71 has a slightly noncircular shape and a dramatically bright center. In large scopes M71 really shows its stuff: a 12-inch scope resolves the cluster clear across its face, unveiling numerous white and pale yellow-orange pinpoints apparently hanging in front of a hazy gray-green backdrop. Although it isn't as large or bright as M13, M71 is nonetheless one of the finest globular clusters for backyard telescopes.

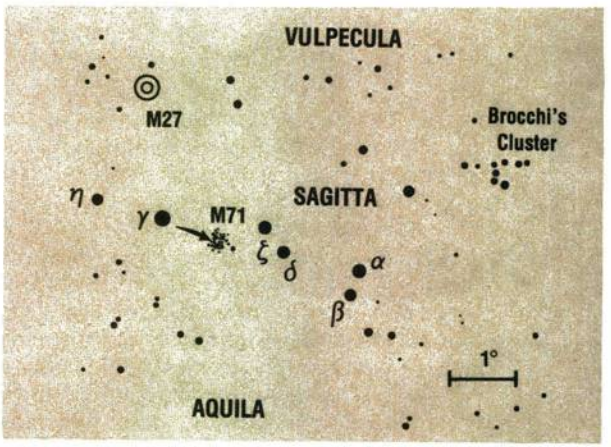
Three globulars are tucked in the constellation Ophiuchus. Similar in size and brightness and separated by a mere 3°, **M10** (NGC 6254) and **M12** (NGC 6218) are easily visible in small scopes. Each glows at magnitude 6.6 and covers about 15′ of sky. To find them, start by placing your finder scope on the 3rd-magnitude star Zeta (ζ) Ophiuchi and move 8° northeast to 5th-

M15
Magnitude 6.4 Size 12.3′ by Jack Newton

M15 IN PEGASUS is the finest globular cluster in the autumn sky. It is visible in the spring after Pegasus rises early in the morning. Look for M15 3.5° northwest of Enif, one of the constellation's brightest stars.



M71
Magnitude 8.3 Size 7.2′ by Martin C. Germano



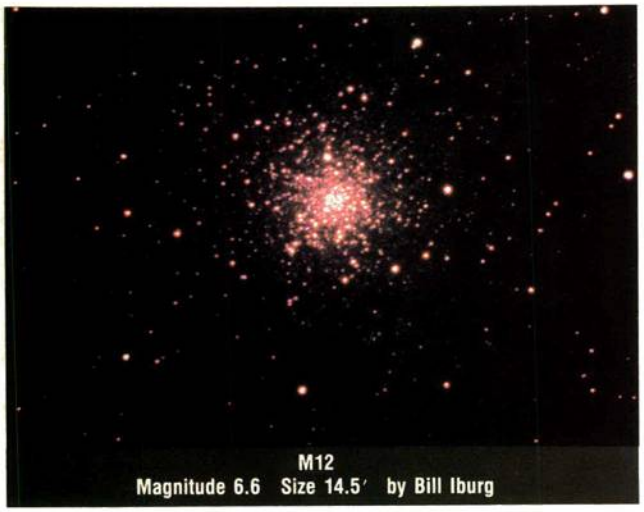
GLOBULAR M71 is so easily resolved that astronomers once thought it may be an open cluster. Locate M71 near a bright double star at the center of Sagitta.

Globulars for Small Scopes

Object	R.A. (2000.0)	Dec.	Mag.	Size	*Tirion*	*Uranometria*
M107	16h32.5m	−13°03′	8.1	10.0′	15	II: 291
M13	16h41.7m	+36°28′	5.9	16.6′	8	I: 114
M12	16h47.2m	−1°57′	6.6	14.5′	15	II: 247
M10	16h57.1m	−4°06′	6.6	15.1′	15	II: 247
M22	18h36.4m	−23°54′	5.1	24.0′	22	II: 340
M56	19h16.6m	+30°11′	8.3	7.1′	8	I: 118
M55	19h40.0m	−30°58′	7.0	19.0′	22, 23	II: 379, 380
M71	19h53.8m	+18°47′	8.3	7.2′	8, 16	I: 162
M75	20h06.1m	−21°55′	8.6	6.0′	22, 23	II: 343
M15	21h30.0m	+12°10′	6.4	12.3′	16, 17	I: 210

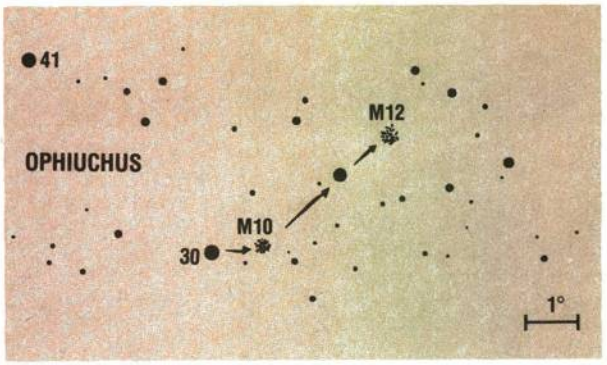
Object: Designation in Messier catalog. **R.A. and Dec.:** Right ascension and declination in equinox 2000.0. **Mag.:** V magnitude of cluster. **Size:** Diameter in arcminutes. ***Tirion:*** Chart on which object appears in *Sky Atlas 2000.0* by Wil Tirion. ***Uranometria:*** Chart on which object appears in *Uranometria 2000.0* by Wil Tirion, Barry Rappaport, and George Lovi.

M10
Magnitude 6.6 Size 15.1′ by Bill Iburg



M12
Magnitude 6.6 Size 14.5′ by Bill Iburg

PAIRED IN OPHIUCHUS, globular clusters M10 and M12 are nearly identical except for star densities. M10 has a bright, condensed core; M12 is easily resolved into myriad stars.



magnitude 30 Ophiuchi. M10 lies 1° west of this star and M12 3° northwest of M10. Both clusters appear like smaller and dimmer versions of the Hercules Cluster. However, M10 has a tightly packed distribution of stars, whereas M12 is somewhat looser. High magnifications reveal star chains and voids across parts of this cluster.

Now return to Zeta Ophiuchi and move 3° south-southeast to find **M107** (NGC 6171). An unusual globular cluster, M107 glows at magnitude 8.1 and covers 10′ of sky, yet it is deceptively hard to resolve. A 10-inch scope does the job under good seeing, but a 12-incher provides a more satisfying view. Large telescopes show that M107's core appears like a grainy, glistening clump.

Sagittarius abounds in globular clusters, as it does with other types of deep-sky objects. Three of the constellation's best globulars are **M22** (NGC 6656), **M55** (NGC 6809), and **M75** (NGC 6864). M22, located 3° northeast of the bright star Lambda (λ) Sagittarii, is in fact one of the finest globulars in the sky. Shining at magnitude 5.1 and measuring 24.0′ across, M22 exceeds the Hercules Cluster in every aspect. It is also far easier to resolve; a 4-inch scope shows moderate resolution. However, its southern declination hurts these impressive statistics for viewers in the Northern Hemisphere.

M55 and M75 lie in the eastern corridor of Sagittarius, away from the Teapot asterism. Locate M55 by sweeping 7° east and 1° south of Zeta Sagittarii. M55 is a large, loose globular cluster that is easily resolved at moderate powers. A 6-inch scope shows it as a 7th-magnitude glow peppered with faint stars. M75, which lies near the Sagittarius-Capricornus border, is a 8.6-magnitude cluster with stars compressed into a 6′ diameter. Resolving this tight cluster constitutes a fine challenge for large telescope owners.

The grand globular of autumn, Pegasus' **M15** (NGC 7078), is a dazzling sight that resembles a scaled-down version of the Hercules Cluster. M15 lies immediately west of a solitary 7th-magnitude star some 3.5° northwest of Enif (Epsilon [ε] Pegasi). With a good finder scope it's a snap to find because M15 is clearly a fuzzy ball of light even in a 6x30mm finder. Once you've located it, increase your scope's magnification to 15x per inch of aperture and carefully sweep over the field. M15 lies in a rather sparse field of faint stars but is itself a beautiful sight.

A 4-inch scope begins to resolve the cluster's edges into stars. A 6-inch scope shows many stellar dots sprinkled across M15 and an intense glow in the cluster's center. The high-power view with a large backyard telescope is stunning: star chains spill out of the field in all directions. Gazing at M15, I get the impression I'm watching myriad other worlds and wonder if perhaps something is looking back at me.

Because these clusters are suspended far away in the Milky Way's halo, viewing them requires peering through slices of the Galaxy itself. Observing some globulars — M10, M12, M22, M55, and M75 — from our position in the Galaxy makes us gaze through a thick section of the Galaxy's disk. Consequently we see these clusters in rich starfields. However, clusters that lie away from the center of the Galaxy — M13, M15, and M56 — lie in relatively sparse fields of stars because our vantage point makes us look through thin parts of the Galaxy's disk. However, whether they lie among numerous, sparkling stars or in just a handful of dim points of light, globular clusters offer pretty views for users of small telescopes. □

Chris Schur is an observer and astrophotographer who lives in Black Canyon City, Arizona. His favorite objects are globular clusters, galaxies, and comets.

ASTRONOMICAL SELECTION

TELESCOPES, BINOCULARS, CAMERAS

CELESTRON

- CLASSIC 8.....999.99
  8" Schmidt Cassegrain
- POWERSTAR 4...SALE
  8" Schmidt Cassegrain w/ Tripod + Wedge
- ULTIMA 8.....SALE
  w/ Tripod + Wedge
- C90.....349.99
  SPOTTING SCOPE
- C4.5.....IN STOCK
  NEWTONIAN REFLECTOR

LOWEST PRICES ON EARTH

OPEN 7 DAYS · 48 HOUR DELIVERY AVAILABLE

BERGER BROS.

CAMERA EXCHANGE

209 BROADWAY (ROUTE 110) · AMITYVILLE, N.Y.

1 (800) 262-4160 • (516) 264-4160

QUESTAR®

WHEN YOU'RE READY FOR A QUESTAR – COME TO US!

NEW ENGLAND ASTRO-OPTICS, INC.

We have become Questar's largest astronomy dealer

(Based on sales for 1987 + 1988)

NEW ENGLAND ASTRO-OPTICS, INC.
Box 834, Simsbury, CT 06070
(203) 658-0701 • Our 5th Year

KRAUTH

PRECISION INSTRUMENTS

SALES & SERVICE

(617) 331-3795

- Zeiss
- Meade
- Fujinon
- Celestron
- Tele Vue
- Swarovski
- Bausch & Lomb

Send for our FREE catalog

528-30 MAIN ST., SOUTH WEYMOUTH, MA. 02190

Astro Photographer's Dream

New Vista Camera Tracker

- Precision tracking
- 96 tooth bronze worm
- 117 V. syncro motor
- Equatorial mount
- Sturdy construction
- Weighs only 4 lbs.
- Mounts on tripod
- Polar axis boresight
- Optional borescope
- Optional weights
- Opt. DC-AC converter

$249 PLUS $5 SHIPPING

CA add 6% sales tax

Send for free literature or call

(805) 922-2545

VISTA INSTRUMENT CO.
P.O. Box 1919-B
Santa Maria, CA 93456

Your best buy in space – ASTRONOMY!

169,204*

ready-to-buy readers will see the ads in this issue!

For information on advertising, call or write:

ASTRONOMY

Dana-Lynne Terry
Advertising Sales Manager
ASTRONOMY
1027 N. 7th Street
Milwaukee, WI 53233
Call toll-free: 800-558-1544

* Average paid circulation for the six months ended Dec. 31, 1988, as filed with the Audit Bureau of Circulations, subject to audit.

NASA Emblems from ASTRONOMY – Manufactured by the Official NASA Supplier

Wear these historic colorful patches on your jacket or cap, or display them in frames – either way you'll be proud to show them.

STS 61A
#35073

STS 61B
#35074

STS 61C
#35075

4" each
$5.49 each

STS 51L
#35076

STS 26
#35077

STS 27
#35078

To order, specify the patch code and product number on the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233. Include for postage and handling; U.S. $1.50; Canada and foreign add 15% ($3.00 minimum). Wisconsin residents add 5% sales tax.

10" LX6: The Best in Astrophotography

FREE $750 Accessory Package

Buy a Meade 2120/LX6, 2120/LX5, or 2080/LX6 and Meade will give you over $750 in optional accessories! Call for details.

Call toll-free for our new low price!

~~$2499~~

Meade 2120 LX6

The Meade 2120 LX6 is one of the best telescopes available for fast, beautiful astrophotography. With a fast f/6.3 focal ratio, exposure time of the Orion Nebula is reduced to just 5 minutes. A 50 minute exposure of the Omega Nebula is reduced to 20 minutes. That means more pictures in less time. Because of the unique design of the LX6 system, lunar and planetary observation are just as crisp and spectacular as with more conventional f/10 designs. Plus, for visual observing, the 10 inch LX6 will give you brighter images with a wider true field than any other Schmidt-Cassegrain with the same eyepiece. Put this all on top of the most advanced quartz drive system made, include an impressive array of standard accessories, and no other telescope compares. No other company saves you as many dollars as National Camera Exchange.

Ask about our $50 instant rebate!

Digital Setting Circles **$349**

Consider the benefits of adding the Digital Readout System. Easily installed to your telescope, the DRS gives you local and sidereal time, declination and right ascension coordinates, frequency of the motors input current, and digital timing for your astrophotographs (important with shortened exposure). All information is displayed on your hand control for accessibility, and makes finding objects faster and easier with an accuracy of almost 5 times above conventional setting circles. Add the advanced Digital Setting Circles for a versatile, easy-to-use system.

Important Accessories

Meade 10" Dew Shade $89
One wasted evening with dew on your corrector plate makes this a must!

Meade Off Axis Guider System $159
Lets you view through your telescope while your camera is attached, providing an easy and accurate way to guide your exposure.

Declination Motor $89
Take full advantage of your astrophotographic capabilities with this critical addition.

Electric Focus Motor . . . . . from $89
Make high power observation easy. Plugs directly into drive base for use from your hand control.

Meade Series 4000 2x Barlow $71
Double the magnification of your current eyepieces for detailed planetary views.

We stock the full line of Meade series 4000 eyepieces. Excellent viewing at an excellent price!

Satisfaction Guaranteed

National Camera Exchange has been a family run business since 1914. With five retail stores in the upper midwest, we are dedicated to helping you learn and enjoy the wonders of astronomy. Call us with your questions. We accept Visa, Mastercard, and Discover, with no additional surcharge, and our prices include shipping. If you are not satisfied with your purchase, you have thirty days to return it. Call us first, and if it is in like-new condition, including all original boxes, warranty cards and packing materials, you are entitled to a full refund, less our original shipping costs. **We work hard for your satisfaction!**

Trade In Trade Up

STORE HOURS: Mon-Fri 9 to 8 p.m. Sat. 9 to 5 p.m., Sun. 12 to 5 p.m.

No time to call us during the day? We're here until 8 p.m. central time weekdays to answer your questions. We're here Saturdays and Sundays, too.

Shipping Costs Included!

Our prices include any shipping and handling charges.

Prices are subject to change.

Since 1914

National Camera Exchange

+Video

9300 Olson Memorial Highway, Golden Valley, Minnesota 55427
For information, call the telescope experts at (612) 546-6831.

TO ORDER CALL TOLL-FREE 1-800-624-8107

BRIGHT SUPERNOVA FOUND IN GALAXY M66

On January 30, 1989, Robert Evans of Hazelbrook, New South Wales, discovered his eighteenth supernova. Evans spotted a 13th-magnitude point of light in the bright galaxy M66 (NGC 3627) that appeared out of place. Later that night Robert McNaught of Siding Spring Observatory in Australia confirmed the discovery through a thin cloud layer using the observatory's Uppsala Schmidt telescope. The star was designated supernova 1989B. Independent discoveries were reported by Federico Manzini of Novara, Italy; Steve Lucas of Midlothian, Illinois; and A. Kane of Exeter, England.

During the following week, many readers with 8-inch or larger telescopes reported observing the new star, describing it as easily visible in the galaxy's northwestern spiral arm. On January 31, Dana Patchick of Culver City, California, estimated the supernova's brightness at magnitude 12.5. The object seemed to be brightening, which was supported by the magnitude estimates of Ronald Royer of Wrightwood, California (12.3 on February 2); Alan Hale of Las Cruces, New Mexico (12.1 on February 3); and J. D. Shanklin of Cambridge, England (12.1 on February 8).

Evans reported the supernova's precise position as 15″ west and 50″ north of the galaxy's nucleus. Professional astronomers working at Arizona's Multiple Mirror Telescope made spectra and quickly determined 1989B was a Type Ia supernova, the brightest of the types.

COMPARISON MAGNITUDES for the supernova field are given in tenths of magnitudes with decimals omitted. The supernova's position is marked with an arrow.

A NEW SUPERNOVA (arrow) nestles in a spiral arm of M66. The supernova glowed at 12th magnitude last February 11. Photo by Kim Zussman.

REGULUS OCCULTED

Observers across the United States watched on January 23, 1989, as the Moon passed in front of the 1st-magnitude star Regulus in the constellation Leo. (See Through the Eyepiece by Rick Shaffer, January 1989.) The event was visible in the eastern United States, eastern Central America, the West Indies, and southwestern Africa. In the United States, the line of visibility extended from central Maine through lower Michigan, central Wisconsin, the South Dakota-Nebraska state line, and on down through western Texas. In mid-evening the star slipped behind the Moon's bright limb and re-emerged from behind the Moon's dark limb an hour later.

Donald Talbert and John Maynard watched the occultation a few miles apart in north-central North Carolina. According to Talbert, "John stationed himself in Jamestown, while I viewed the event sev-

M66: BEFORE AND AFTER the supernova. The left-hand image was taken on May 17, 1985, the image at right on February 2, 1989. Photos by Ronald E. Royer.

enteen miles away in Greensboro, hoping to detect a difference in disappearance and reappearance times." They did. Talbert witnessed a disappearance at 8:44:34 p.m. EST and saw the star reappear at 9:45:43 p.m. Maynard recorded a disappearance time of 8:44:25 p.m. and a reappearance time of 9:45:41 p.m. Although a few seconds of the difference between Talbert's and Maynard's times may have been error, some of the difference reflects that the occultation occurred a few seconds apart over the tiny distance of seventeen miles.

"The sky was dark but contained patchy fog when I observed the occultation," said Michael E. Boschat of Halifax, Nova Scotia, who observed the event from near the graze line. "I used a 3-inch refractor and noticed that at 7:18:11 p.m. AST the star seemed to begin slowly fading. However, Regulus did not blink out. At 7:41:31 the star began to brighten again. Did any other amateurs see this effect, especially if they were near the graze line?"

SHOWTIME ON THE SUN

Mario Rene Ortiz Davilla, an enthusiastic observer of sunspots in Guatemala City, Guatemala, thinks the Sun's not getting the attention it deserves. "Halley and Mars Mania did a lot for amateur astronomy," said Davilla, "but now they belong to the past. I think it's time for the Sun's showtime." Solar activity continued to rise during the final months of 1988, slowly building toward a solar maximum in 1990 and 1991.

"For example, last December 21," Davilla continued, "I observed the Sun's disk when it was covered with sunspots. I have been monitoring the Sun regularly, and just two months before that date I was typically seeing one fourth the sunspots I began recording in late December. I make the observations with a 2.4-inch f/15 refractor at 227x. The telescope is of course fitted with a proper solar filter."

In the United States the Sun's activity is not going unnoticed either. During the past ten years Peter O. Taylor has supervised the American Sunspot Program, a project with the goal of recording and analyzing sunspot activity. Taylor heads the Solar Division of the American Asso-

Cambridge University Press

The Cambridge Atlas of Astronomy, Second Edition
Edited by Jean Audouze and Guy Israel

The most comprehensive and authoritative astronomy reference available, this invaluable guide is intended for amateur astronomers as well as anyone with a deep interest in space research and astronomy. This thoroughly revised edition has been meticulously updated to incorporate the latest developments. It includes the 1986 appearance of Halley's Comet; 1986 Voyager space probe encounter with Uranus; 1987A Supernova; and information on the newest telescopes.

Approximately 1100 photographs and illustrations. 350 color and 420 black-and-white photographs from the world's most prestigious observatories. 330 color diagrams, 47 tables and 3 star maps. Oversized format.
1988 / 432 pp. / 36360-8 / Hardcover $90.00

The Moon Observer's Handbook
Fred W. Price

This book outlines everything an amateur astronomer needs to know in order to undertake lunar observations, including how to make observations, exactly what to look for and how to record them. It is supported throughout by a unique set of drawings as well as a series of excellent photographs.
1989 / 308 pp. / 33500-0 / Hardcover $34.50

NGC 2000.0
The Complete New General Catalogue (NGC) and Index Catalogue (IC) of Nebulae and Star Clusters
Edited by Roger Sinnott
Co-published with *Sky & Telescope*

A thorough listing and revision of objects catalogued a century ago by the famous observer J.L.E. Dreyer, this new catalogue lists 13,226 nebulae, star clusters and galaxies. In addition to modern positions, sizes, brightnesses and object types, the catalogue includes Dreyer's complete descriptions.
1989 / 304 pp. / 37813-3 / Paper $19.95

Pathways to the Universe
Sir F. Graham-Smith and Sir Bernard Lovell

This illustrated introduction to astronomy starts from a level of common experience and develops the subject to the frontiers of modern research. The book explains how to become an astronomer and how to find your way around the sky using simple binoculars, a telescope, or the naked eye.
1989 / 244 pp. / 32004-6 / Hardcover $24.95

The Guide to Amateur Astronomy
Jack Newton and Philip Teece

This guide introduces all the fundamentals of astronomy with an emphasis on practical techniques. Newton and Teece provide an in-depth exploration into the field of astrophotography detailing techniques ranging from simple tripod photography to cold camera photography.
1989 / 327 pp. / 34028-4 / Hardcover $24.95

Practical Astronomy with Your Calculator, Third Edition
Peter J. Duffet-Smith

Using clear and logical routines, the author shows how a variety of problems and exercises in modern astronomy can be readily solved with a scientific calculator. It keeps complexities and mathematical sophistication in the background.
1989 / 185 pp. / 35699-7 / Spiralbound $16.95

At bookstores or order from

Cambridge University Press

32 East 57th Street, New York, NY 10022.
Cambridge toll-free numbers for orders only:
800-872-7423, outside NY State. 800-227-0247, NY State only.
MasterCard and Visa accepted.

DS-10 $99.00
DS-16 $199.00
Rotatable Ring Mounts for Mead Deep Sky Scopes Now Available.
We Will Consider Other Custom Rings On a Cost + Basis

DENNY'S ASTRO MART
832 SIDNEY BAKERKERRVILLE, TX
(512) 896-6377
UPS Shippable-Allow 4-6 Weeks
Please include $10 Shipping & Handling in Con. U.S.

METEORITES!
AUTHENTIC SPACE COLLECTIBLES
Display stands, space jewelry, books, photographs. Catalog $2. (Refundable)
BETHANY TRADING COMPANY
P.O. BOX 3726-A,
NEW HAVEN, CT 06525
CATCH A FALLING STAR!
(203) 393-3395

STAR SEARCH

- VHS, BETA, 8 MM
- Need only TV and VCR. No computers or complicated equipment
- Introduction and Review to Astronomy and Celestial Navigation
- Repeat as desired, when and where needed
- Plain language, easily understood
- Interesting for all ages
- Solar System, Stars, 42 Constellations, Planets
- Discount for Boy Scouts, youth groups
- 30 day Unconditional guarantee
- $59.50 + 2.50 P&H, (Calif +6%)

WIN BOX 1869, DEPT. A HEALDSBURG, CA 95448

Telescopes • Binoculars • Astro-Aids
Bausch & Lomb, Bushnell, Questar, Celestron, Jason, Meade, Edmund Scientific, Steiner, Fujinon, Vixon, etc.
PAULI'S WHOLESALE OPTICS-"IMPORT/EXPORT"
29 Kingswood Rd., Danbury, CT 06811 USA
Tel: 203-746-3579 9 a.m. — 9 p.m. Mon. — Sat.
Catalog/Data Package (1 lb.) $3.00; VISA, M/C 3%

Be sure to mention ASTRONOMY when responding to an advertisement!

QUASAR OPTICS
"Western Canada's largest stocking telescope dealer."
BINOCULARS
BOOKS
ASTRO MAPS
MICROSCOPES
POSTERS
SPOTTING SCOPES
TELESCOPES

SALES — REPAIRS
CONSIGNMENTS
CATALOGUE $4.00
(403) 255-7633
7220A FAIRMOUNT DR. S.E.
CALGARY, ALBERTA T2H 0X7
-CANADA- -CANADA- -CANADA-

Meade Instruments from Cosmic Connections
Meade at competitive prices! *Call now!* 312-851-5353 800-634-7702

2080/2120 LX6 Superfast F/6.3

- 59% Wider Field
- 60% Shorter Exposure
- New Advanced Electronics
- CAT & DSC Options

Meade CAT Option

Find Deep Sky Objects in a flash with CAT
Meade DSC Optional Digital Setting Circles

Series 4000 eyepieces
Super Plossls
Super Wide Angle
Ultra Wide Angle

Cosmic Connections Chicagoland's only Astronomy Specialist 1460 N. Farnsworth Aurora, IL 60505

REACH FOR THE STARS

COSMIC CATASTROPHES
Clark R. Chapman and **David Morrison**
"The real story behind the barrage of claims and arguments about cosmic disasters."
—**Andrew Franknoi,** Executive Director, Astronomical Society of the Pacific
0-306-43163-7/ill./296 pp./$22.95 (hardcover)

HUMANS IN SPACE
21st Century Frontiers
Harry L. Shipman
"An inspired, yet sound, look at the future of human beings in space."
—**John Pike,** Federation of American Scientists
0-306-43171-8/ill./350 pp./$22.95 (hardcover)

THE STORY OF PHYSICS
Lloyd Motz and **Jefferson Hane Weaver**
"[Lloyd Motz] is one of the great explainers . . .he makes things clear without ever being simplistic."
—**Hugh Downs,** host of *ABC's 20/20.*
0-306-43076-2/ill./402 pp./$24.50 (hardcover)

PLENUM PUBLISHING CORPORATION
233 Spring Street
New York, NY 10013-1578
1-800-221-9369 (212) 620-8421
THE LANGUAGE OF SCIENCE Plenum PUBLISHING CORPORATION

Wholesale Optics of Pennsylvania
for all your Astronomical Needs

TELRAD® w/Base $38.95

B&L 8 x 50 FINDER $46.95
BKTS: Spec. SCT or Newt. $22.00

EYEPIECE SPECIAL
7MM Meade Research Grade Ortho $45.95
Multi-Coated

Tele Vue
Finest Plossels, Widefield, Naglers in Stock.
Lowest Prices! Genesis 4" (101MM) F5 Fluorite 500MM Refractor $1,279.95
Panoramic Brass & Wood Mount $ 349.45
CALL OR WRITE FOR ALL TELEVUE PRODUCTS

JIM'S MOBILE
Moto-Focus... $ 77.95
Moto-Decs $75.95
For LX3, 5, 6
Focusers and Decs. for all scopes.

MEADE ACCESSORIES
WFAS $116.00
Off Axis Guider System 146.00
#680 Deluxe 1¼/2" Focuser 89.00
1¼" Basic Camera Adaptor 38.00
1¼" Variable Camera Adaptor 49.00
#908 1¼" Nebula Filter 59.00
#911 Rear Cell Nebula Fil. 99.00
#1A Skylight/Dust Filter 44.00
#1¼" Polarized Filter 12.50
1¼" Color Filters-All colors 12.50
#905 Var. Polarizer Syst. 46.00
8" Dew Cap 58.00
10" Dew Cap 86.00
8" LX Counter Wgt. Set 80.00
10" LX Counter Wgt. Set 89.00
#928 Diag. Erecting Prism 48.00
LX3's, LX5's, LX6's, CALL
All 4000 Eyepieces & Accessories

ACCESSORIES
T-Rings $10.00
T-Adaptors 24.95
Tele-Extenders 24.95
Drives for Tasco 89.95
Celestron 1¼" Orthos 42.95
Celestron Dewstar 8" 18.00
Celestron 8" Cnterwgt.Ass. 89.00
Celestron 2" Wide Star Diag 99.00

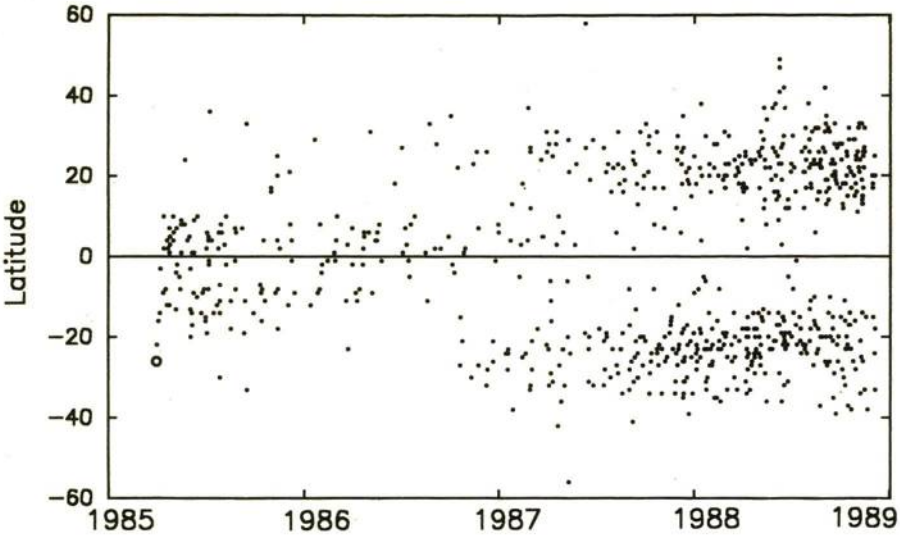
EDMUND SCIENTIFIC
1¼" RKE 8, 12, 15, 21 or 28MM .. $37.95
RKE 2.5 Barlow 52.95
1¼" Orthos: 4, 6, 12.5, 18 or 25MM 42.95
Ortho Zoom 8.4 - 21MM 79.00
1¼" Kellners 6, 9, 12 or 18MM 31.95
1¼" Erfle: 20MM....$49.95 32MM . 69.95
Astro Scan 2001 4¼" Richfield Scope $259.00

SUPER SAVINGS
PORTA PAC
Power your scope with this rechargeable battery pack up to 12 hours.
Wt. only 5 lbs. $65.95

Get Ready for Sunspot Maximum w/Solar Filters
Mylar, Glass I, II & III for all size scopes
8" Type I.....$84.45 Type II $114.95
For perfetly focused astrophotos
Sur-Sharp® by Spectra $119.00

DIGITRAK II CORRECTORS BY VOGEL FROM $119.95
MEADE • CELESTRON • TELEVUE • B&L • BRANDON • PARKS • EDMUND • UNIVERSITY OPTICS

Wholesale Optics of Pennsylvania
Box 15, Sterling PA. 18463-0015 U.S.A.
(717) 842-1500 or (717) 344-5217 until 11 p.m.
P. List send SASE 3% Cr. Cg. Cat. $3.00
ULTRA LOW SHIPPING



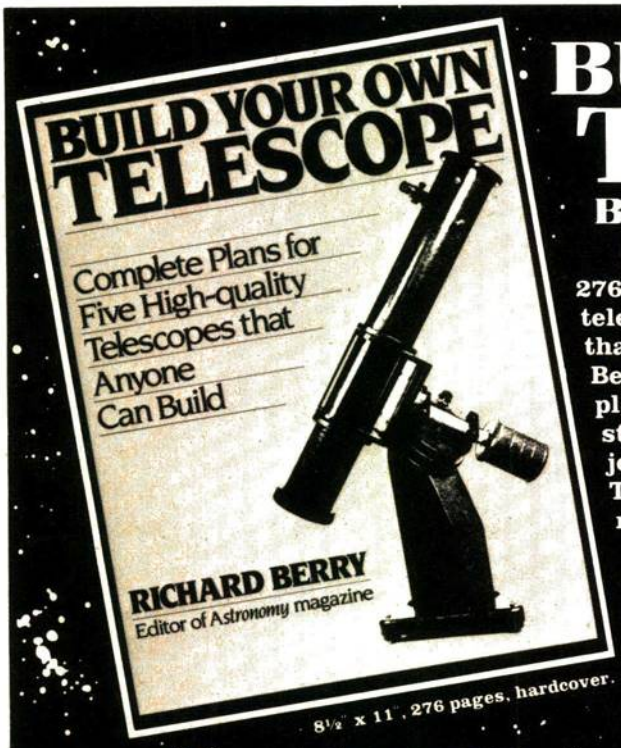
A "BUTTERFLY" DIAGRAM shows the overall pattern of sunspot activity between April 1985 and November 1988. The latitude where each sunspot group emerges is plotted as a filled circle. The single point shown as an open circle may be the first high-latitude group of the current solar cycle. Diagram by Peter O. Taylor.

SOLAR STORMS marked the Sun's surface on December 23, 1988. Mario Rene Ortiz Davilla sketched the spots with his 2.4-inch refractor at 227x.

ciation of Variable Star Observers (AAVSO), a Cambridge, Massachusetts-based group that serves as a clearinghouse for observations made by professional and backyard astronomers.

Taylor's current project uses data from amateur observers to construct a "butterfly diagram" that shows recent sunspot activity. (Such diagrams were nicknamed because of their distinctive shapes.) The diagram features data from 1985 to 1988 and reveals an overlap of the Sun's last cycle and the current one, which began in April 1985. The graph also shows that spots apparently produced in both cycles coexisted for more than three years.

These data illustrate that there is a great deal yet to learn about the Sun's variability. Taylor's group wants to continue collecting data so members of the AAVSO and professional astronomers can study the data, searching for clues about the Sun's changing behavior. — *David J. Eicher* □



BUILD YOUR OWN TELESCOPE

By Astronomy Editor Richard Berry

Build Your Own Telescope is a new, informative, 276-page book that shows you how to make your own telescope – at far less cost and with less time and effort than you ever imagined! By ASTRONOMY's Richard Berry, Build Your Own Telescope features complete plans for five telescopes, along with easy-to-follow, step-by-step instructions and photos. For these projects, you'll need no special tools, and Build Your Own Telescope will tell you where to obtain all the components needed!

Build Your Own Telescope includes introductory chapters on how telescopes work, and discusses telescope optics, mountings, and accessories. And for a real challenging project, there are chapters on grinding, polishing, and testing telescope mirrors!

8½" x 11", 276 pages, hardcover.

$24.95

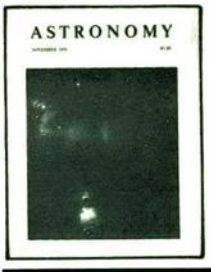
#30124

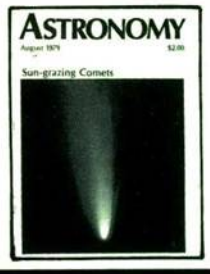
Build these telescopes!

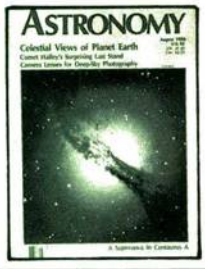
- 10" f 6 Newtonian
- 6" f 8 Dobsonian Reflector
- 6" f 8 Equatorial Reflector
- 6" f 15 Refractor
- 4" f 10 Equatorial Reflector

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233. Include for postage and handling: U.S. $1.50; Canadian and foreign add 15%. Wisconsin residents add 5% sales tax.

Guide to Back Issues







DOES YOUR ASTRONOMY LIBRARY NEED UPDATING?

Would you like to catch up on computers in astronomy? Did you miss our coverage of Halley's Comet? Are you looking for a Telescope Buyer's Guide? If you missed these or any other exciting issues of ASTRONOMY, here's your chance to complete your collection.

To order, print the month and year of those you want on the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. Seventh St., Milwaukee, WI 53233. Please list the issues in order by date. Include for postage and handling: U.S. $1.50; Canada and foreign add 15% (minimum $3.00). Wisconsin residents add 5% sales tax.

1973-1978 • $4.00

September 1973: The Surface of Mars, Film: A Grainy Dilemma for Sky Shooters

October 1973: The Hurtling Moons of Barsoom, Kohoutek: Great Comet of the Century, Integration Printing: An Aid to Long Exposure Astrophotography

November 1973: Cosmic Dimensions, It's Simple to Photograph Constellations

December 1973: Life on a Neutron Star, Highlight Masking: A Method of Detail Enhancement

January 1974: Birth and Death of a Comet, Observing Nebulae and Clusters, Interacting Galaxies

February 1974: Encounter with Jupiter, Moon and Sun Photography, Exploding Galaxies

March 1974: The Cosmic Abyss, What Happened to Comet Kohoutek?, Magnetic Fields Beyond Earth, Photography With Small Telescopes

April 1974: The Canals of Mars, Beyond the Black Hole, Comet Kohoutek Pictorial, Between the Stars

May 1974: The Forbidden Moons, The Lost Pictures of Mars, Slide Copying Improves Color Photos

June 1974: Planetary Bonanza

July 1974: Astronomy From Skylab, What Radio Eyes Would See, Some Elements of Astrophotography, An Introduction to Small Telescopes

August 1974: What Chariots of Which Gods?, Catch a Falling Star

September 1974: Planet of the Double Sun, Jupiter Looms Into View, Tell the Planets to Say "Cheese"

October 1974: The Lost Planet?, Inside Gould's Belt, "Which Color Film Should I Use?"

November 1974: New Jovian Vistas, Sky Photography Without a Telescope

December 1974: The Zeta Reticuli Incident, What's In Martian Craters?, Measuring Star Diameters

January 1975: Beyond the Milky Way, Saturn — The New Frontier, Getting to Know Your Telescope, Piggyback Astrophotography

March 1975: Future Exploration of the Moon, Interstellar Molecules, The Eyepiece

May 1975: The Search for Intelligence, Exploration from Space

June 1975: From Dust to Dust (stellar evolution), The Changing Surface of Mars, Rich Field Telescopes

July 1975: The Quest for Life on Mars, The Age of Nearby Stars, Mysteries of the Galactic Core

August 1975: Faster Than Light?, Observing the Perseids, The Great Red Spot

September 1975: Baptism of Fire, The Quasar Dilemma, Let's Take a Look at the Sun, Building a Solar Projection Screen

October 1975: Starspots on Betelgeuse, Shape of the Milky Way, Observing Jovian Detail

November 1975: Big Bang to Galaxy, Mars' New Frontiers, Find a Comet

December 1975: Astronomy from the Moon, The Planet Mercury, Stellar Beehive

January 1976: In the Beginning, Colonies In Space, The Zeta Reticuli Incident

February 1976: Io, Exploding Stars, The Gibbous Moon

March 1976: Beyond Space Shuttle, Infrared Astronomy, Life's Protective Shield (magnetic field reversal)

April 1976: Finding Unseen Worlds, Dust Clouds and Ice Ages, Your Most Valuable Equipment (Your Eyes)

May 1976: Quasars: Oddities of Space, Cosmic Explosions, Molecules of Life, Choosing B&W Films, Observing Galaxies

June 1976: Asteroids, Viewing the Full Moon, What You Can See Through a Small Refractor

July 1976: SPECIAL ISSUE (32 extra pages!) The History of American Astronomy. Complete from prehistory through Palomar

August 1976: Venus, Clusters of Galaxy Clusters, Exploring the Milky Way, Part 1, Red Light Sky Photography

September 1976: MOON ISSUE. The Moon's Early History, Science on the Moon, The Last Quarter Moon, Developing B&W Astrofilms

October 1976: Radio Interferometry, Searching for Mars on Earth, Birthplaces of Stars, Star-Test Your Telescope

November 1976: The Space Telescope, Black Holes, White Holes and Wormholes, Doubles, Binaries and Multiple Stars, Schmidt Cameras

December 1976: The Magellanic Clouds, Printing Your Astrophotographs, Part 1, The Messier Catalog, Cleaning Your Telescope Mirror

January 1977: MARS ISSUE. Viking on Mars: Exciting Results, Life on Mars: Ambiguous Results, Printing Your Astrophotographs, Part 2, Exploring the Milky Way, Part 2

February 1977: Uranus and Neptune, Pluto, Miniblack Holes, Cold Cameras, Part 1

March 1977: Phobos and Deimos, New Color Photos of Galaxies, Cold Cameras, Part 2, Binoculars for Stargazing: Part 2, Observing from the City

April 1977: Supernovae!, Printing Your Astrophotographs Part 3, Building a 6" Reflector, Part 1, Observing the Outermost Planets

May 1977: The End of Time, Can Life Evolve in Elliptical Galaxies? Building a 6" Reflector, Part 2

June 1977: Gamma Rays and the Origin of Cosmic Radiation, Observing with Binoculars

July 1977: The X-Ray Universe, What Makes Novae Blow Up?, Astrophotography with Telephoto Lenses, Tracking Asteroids

August 1977: Slow Boat to Centauri, Building a 6" Reflector, Part 3, Assembling Your Telescope

September 1977: Stars With Companions, Robot Probes, Building a 6" Reflector, Part 4, Light Pollution

October 1977: MARS ISSUE. The Polar Regions of Mars, Buyers Guide to Small Telescopes, "Red Variable" Stars

November 1977: The Revolution in Astronomy, The Southern Sky

December 1977: Why Do Planets Have Rings? Tunguska, Learning the Constellations, Part 1, Printing Your Astrophotographs, Part 4, Tuning in on Radio Astronomy

January 1978: Our Sun, Photographing the Sun in H-Alpha, Observing Herschel Objects, Building a 6" Reflector, Part 5

February 1978: Why Does Earth's Climate Change? Photograph the Moon!, What You Can See Through a 6" Telescope

March 1978: Swarms of Stars: Cosmic Calibrators, Rival Cosmologies, Isophote Mapping, What's Inside Your Telescope, Part 1

April 1978: Beyond Centauri, Brown Dwarfs and Black Holes, What's Inside Your Telescope, Part 2, Learning the Constellations, Part 2

May 1978: Terraforming, Blink for a Nova!, The "Big Four" Asteroids, Celestial Software, Right Ascension and Declination

July 1978: Red Dwarf Stars, What's Inside Your Telescope, Part 3, Are Galaxies Here to Stay?, Celestial Software, Telling Time, Learning the Constellations, Part 3

August 1978: EARTH ISSUE. The Early History of Planet Earth, Earth's First Oceans, What's Inside Your Telescope, Part 4, Naked Eye Astronomy, Part 2

September 1978: The Redshift Problem, The Dark Sky Paradox and the Origin of the Universe, Altitude and Azimuth

October 1978: Are Black Holes Really There?, Learning the Constellations, Part 4, Build Your Own Telescope

November 1978: ECLIPSE ISSUE. Asteroid Mining, Observing Earth from Space, Film the Eclipse!

December 1978: Pluto — Planet or Imposter?, ODYSSEY — The Young People's Magazine of Astronomy, The Wet Side of Color Astrophotography

1979-1983 • $3.50

January 1979: Are We the Only Intelligent Life in Our Galaxy?, Is There a New Lunar Crater?, Photographing Star Clusters, Hunt a Cluster

March 1979: Planetary Nebulae, Part 1, Nebular Filters, Patrolling the Planets

April 1979: Look Who's Moving into Our Neighborhood, Voyager Approaches Jupiter, Pioneer Venus First Results, Planetary Nebulae, Part 2

May 1979: A Voyage to Jupiter, The Great Midwinter Eclipse

June 1979: Gravity Wave Astronomy, The Moon: the Southern Highlands

July 1979: What Makes a Spiral Galaxy?, Does Cosmology Have a Future?, Brightness and Magnitude

August 1979: The First Second of Time, The Sun-Grazers, More About Nebula Filters

September 1979: Return to Jupiter, The Great Red Spot, The Jovian Clouds

October 1979: Buyer's Guide to Telescopes, The Top 21 Deep-Sky Objects, The Cosmological Principle

November 1979: Pioneer at Saturn, High Resolution Astrophotography, The Moon: Mountains, Basins, and Scarps, Mass Loss from Stars

December 1979: The Quasar Connection, Equipment for Observing the Sun, Tricolor Astrophotography

January 1980: Alien Eyes, Satellite Views of Earth, Wide-Field Sky Photography, Was Einstein Wrong?

February 1980: Southern Skies Explored, A (Sad) Tale of Two Comets, Cool Your Telescope, Are Blazars Quasars?

March 1980: The Colors of Deep Space, The Cooling Fire of Creation, Photographing the Sun, Building a Sundial

April 1980: Return to the Moon, What Accessories Do You Really Need?, Using SO-115 Film

May 1980: The Colors of Mars, Asteroids: The Flying Mountains, The Afro-Indian Shadow Connection, An Album of Galaxies, Sunspots

July 1980: The Great Red Spot, Mysterious Pluto, Stalking the Gaseous Nebulae, How to Build a Dobsonian Telescope, Part 2, The Puzzle of SS-433

September 1980: Four New Worlds (Jovian Satellites), 21 Challenging Deep-Sky Objects, A Darkroom for Astrophotography, What's My F-Ratio?, The Lively Meteorites

October 1980: Why All the Fuss About Quasars?, How to Buy a Telescope for a Child, Getting the Most from Your Deep-Sky Negatives, Space, Time and Black Holes

November 1980: An Imaging Revolution (Electronics), Universe: Time Zero, North American Solar Eclipses: The Next 50 Years, Processing Your Astronegatives

December 1980: Of Transits and Timeballs, Keeping Warm While Stargazing, The Moon: Ring Mountains and Walled Plains

February 1981: Voyager: Science at Saturn, Cold Camera for Astrophotography, All About Telecompressors, Observing Peculiar Galaxies.

March 1981: Venus by Radar, Observing Gas Giants, Bare-Bones Astrophotography, Solar Magnetism

April 1981: The Tektite Controversy, Mining a Meteor Crater, Hypersensitizing, Part 1, All the Angles on Magnification, Image Orientation, The Fallen Sky

May 1981: The Solar Maximum Mission, The View from Io, The Moon: Rilles and Wrinkle Ridges, Hypersensitizing, Part 2, The Invisible Universe

June 1981: Probing the Chemistry of Galaxies, Observing Planetary Nebulae, Getting the Correct Exposure, Flare Stars

July 1981: Mars: 5 Years After Viking, The Electronic Sky, July's Lunar and Solar Eclipses, The Age of the Universe

August 1981: Space Shuttle, Watch for the Meteors, Beginner's Guide to Telescope Types, Saturn Update

September 1981: Mr. Halley's Hairy Star, The Pleasures of Deep-Sky Observing, Handcrafted Homebuilt Telescopes, The Infrared Universe, Part 1

October 1981: The Star Clouds of Magellan, 1981 Telescope Buyer's Guide, Starting an Amateur Astronomers Club, The Infrared Universe, Part 2

November 1981: Voyager 2 at Saturn, Observing for Pleasure — Urban Astronomy, Cold Camera vs. Gas Hypering, Stellafane and the Art of Telescope Making

March 1982: Secrets of Interstellar Stars, How to Plan a Newtonian Reflector, The Molecules Between the Stars

May 1982: Space Probes for the 80's and 90's, Observing Edge-On Galaxies, Amateur Astronomy

June 1982: The Electromagnetic Spectrum, Rethinking Your 60mm Refractor, How Much Sky Can My Camera Capture? The Vanishing Act of Carbon Giant

July 1982: Landscapes of the Solar System, Do You Really Need a RFT?, Revealing the Venusian Secrets

August 1982: Backtracking the Comets, Smile — You're on Radar, Photographing the Home Galaxy, Easy Steps to Perfect Polar Alignment, STS-3

September 1982: Solving the Mysteries of Venus, Astronomy in the Garden, What Heats the Solar Corona?

November 1982: Inside the Quasars, The Hidden Mass of Galaxies, Binoculars: Choosing and Using Them

December 1982: A Celebration of Light: Yerkes in Perspective, A Year's Harvest of Pictures, Contact Binaries: Stars That Touch, The Telescope Revolution

---

January 1983: To Sculpt the Galaxies, Space Art in Hawaii, A Mini-Observatory for Your Backyard, The Great 1983 Almanac Skychart

March 1983: The First Martians, Radio Astronomy from Your Backyard, How to Be a Halley Watcher

April 1983: Voyager to Uranus and Neptune, Venus Radar Mapping Mission, Sketching the Moon and Planets, How to Star Test Your Telescope, Infra-Red Astronomical Satellite

June 1983: How Far the Stars, Waiting for Halley, Computing the Skies, Astrophotography: A Novice's View, Cosmology on a Computer

July 1983: The Quest for Black Holes, Shooting the Sun in Hydrogen-Alpha, Studying Galactic Structure with Binoculars, Cosmology on a Computer Part 2, Using Setting Circles

August 1983: Celestial Winds, Polar Lights, Comet Swift-Tuttle and the Perseids, 50 Finest Double Stars for a 60mm Refractor, Amateur Astronomy and the Home Computer

September 1983: Return to the Planets, Four Probes to Comet Halley, Total Solar Eclipse in Java, Short Focus Photography, X-rays from Stars, Binoculars and Binaries

November 1983: Geology from Space, Discover the Pleiades, Simple and Inexpensive Tricolor Photography

December 1983: A New Mission to Saturn, Life on Europa?, Photographing Detail in Galaxies, A Symposium on Telescope Control with Microcomputers

1984-1986 • $3.00

January 1984: A Bigger and Better Milky Way Galaxy, Add Drama and Interest to Your Astrophotos, Clocks and Calendars for Astronomy

March 1984: IRAS and the Infrared Universe, Probing the Constellations of Spring, The Planck Era, A Homemade Finder Scope Mount

April 1984: Superclusters: Giants of the Cosmos, Stars Too Small to Burn, Astronomy From the Shuttle, Computing Times of Sunrise, Sunset and Twilight

May 1984: Planetary Atmospheres, How to Observe and Photograph the Annular Solar Eclipse, MMU: Man Flies Free

June 1984: Space Stations: The High Frontier, The Star Tar in the Jupiter Jars, Cosmic Jets: Bipolar Outflows in the Universe, How to Observe Satellites

July 1984: White Dwarfs: Big Things in Small Packages, Those Amazing White Dwarfs, Report on VR-1000, A New Source of Cosmic Rays?, Make Your Dobsonian Telescope Easier to Use

August 1984: Astronomical Ballooning, Spectral Visions, Part 1: The Long Wavelengths, Isophote Mapping, Observing the Sun, The Coming of Epoch 2000

September 1984: Solar Max Returns, IRAS Views the Galaxy, Spectral Visions, Part 2: The Short Wavelengths and Beyond, Against All Odds: Matter and Evolution in the Universe, Building an Equatorial Tracker for Astrophotography

October 1984: Looking for Extrasolar Planets, High Resolution Lunar Photography, Are Quasars Far Away?, How to Choose a Deep-Sky Telescope

November 1984: Mystery of the Missing Mass, Fossils of Something Interesting: The Large-Scale Structure of the Universe, Television in Astronomy, Part 1, Does Space Have More Than Three Dimensions?, Photographing Meteors in Winter

December 1984: Soviets to the Moon: The Untold Story, Television in Amateur Astronomy, Part 2, Tuning into the Interior of a Star, Successful Schmidt Camera Photography

---

January 1985: The Universe, Bit by Bit, The Observatories of Jai Singh, Exposure in Astrophotography, How to Revive a Tired Astronomy Club, Can Comets Become Asteroids?

February 1985: Through Monster Eyes, Discovering the Expanding Universe, Find Halley's Comet by Blinking, An Intensified Evening at the Telescope, Astronomical Ballooning 2, Computing the Ephemeris of Comet Halley

March 1985: Comets: Key to Our Solar System, The Return of Halley's Comet, Comets, "Death Stars," and Extinctions, Making an Astrophotographic Mosaic, Build a Simple Folded-Refractor Telescope

April 1985: British Astronomy Reaches New Heights on La Palma, Eclipse Over Oceania, Build a $6 Eyepiece Warmer, Cold Dark Matter and the Origin of Galaxies

May 1985: Ancients of the Universe: Globular Clusters, Celestial Pinwheels: Spiral Galaxies, Southern Schmidt Photos, How to Use a Polefinder, When Stars Coalesce

June 1985: The First Colony on Mars, Observing Prospects for Halley, Much Ado About 0.1mm, The Anatomy of a Nebula, The Dobsonian Dolly Transport

July 1985: Intelligent Life in Space, Deep-Sky Duos, My Quest for a Planetary Telescope, The Rise and Fall of the Early Reducing Atmosphere

August 1985: Probing the Orion Nebula with the IUE, The Road to Discovery, The Gentle Art of Comet Photography, How to Plot Star Maps on Your Computer

September 1985: Uranus: On the Eve of Encounter, Getting Started with a Schmidt Camera, A Portable Astrophotography Platform, Stellar Evolution Through Mass Loss, Part 1

October 1985: SPECIAL 144-PAGE ISSUE: All About Halley's Comet

November 1985: Palomar and the Politics of Light Pollution, Your First Shot at Halley's Comet, How to Get Started in Piggyback Astrophotography, Stellar Evolution Through Mass Loss, Part 2

January 1986: Deep Time: The Fate of the Universe, Building the Space Telescope's Optical System, Amateur Astronomers Observe Halleys Comet, How to Revive Dull Astrophotos, Astronomy and Astrology: East vs. West

February 1986: Epsilon Aurigae, Giacobini-Zinner: 1985's Best Comet, Voyager's Path of Discovery, Halley Draws Nearer, A Compact Mount for a Compact Scope

March 1986: Halley's Comet Passes the Pleiades, Halley At Its Best, Observing Halley's Comet with Color Filters, Astrophotography with Your Alt-Azimuth Mounting

April 1986: Uranus - The Voyage Continues, Halley Plunges Behind the Sun, How I Designed the Ultimate Astrographic Telescope, The Changing Face of Comet Halley

May 1986: Voyager — Discovery at Uranus, Halley: End of Act One, Fundamentals of Astrophotography, Building a Copyscope, Following Halley Out

June 1986: Giotto Encounters Comet Halley, Halley Emerges in the Morning, Getting Started in Photoelectric Photometry, Intensely Seeking Halley

July 1986: Pluto: Enigma on the Edge of the Solar System, Halley Fades in Early April, Photometry of Variable Stars and Asteroids, Astrophotography with Tech Pan 2415 Film, Space Science After Challenger

August 1986: Eyes on the Earth, Site Wanted: Three Domes, Stellar View, Halley Brightens One Last Time, Camera Lenses for Deep-Sky Astrophotography

September 1986: What Have We Learned From Comet Halley?, Last Look at Halley, Astrophotography with Image Intensifiers, Hunting Martian "Astroblemes", Goodbye, Halley!, Processing Astroslides Yourself

October 1986: SPECIAL 144-PAGE ISSUE: Includes The 1986 ASTRONOMY Guide to Telescopes and Astronomy Equipment Directory; also In and Around Black Holes, The New Improved Palomar Sky Survey, Guiding Magnification for Top-Quality Astrophotos, Viewing Comet Halley this Fall and Winter

November 1986: On Course for Neptune, Why Can't We Explore a Comet?, Advanced Astrophotography, Eclipse Predictions on Your Computer, The View From Europa

December 1986: The Story of Mount Wilson Observatory, In Search of Dark Nebulae, Binoculars for Astronomy, How to Conquer the Messier Objects, The Rotation of the Sun

1987-1989 • $2.50

February 1987: Has Cosmology Become Metaphysical?, Shooting Galaxies from the Suburbs, Sculpting the Moon

March 1987: The Changing Face of Mars, Touring the Stellar Cycle, Gearing up for Summer Deep-Sky Observing, Hidden Images: Dissecting Bright Nebulae

April 1987: Has Cosmology Become Metaphysical?, What Time Is It? (Computing Sidereal Time), Shooting Galaxies from the Suburbs, The Planets of Summer, Sculpting the Moon

May 1987: M-87: Describing the Indescribable, Voyage into the Third Dimension, Photographing Our Nearest Star, Building Fun Telescopes for Less than $10, Observing Spring Galaxies with Binoculars, To the Big Bang and Beyond

June 1987: Search for the Primitive, ASTRONOMY's 1987 Summer Travel Guide, A Burst of Discovery: The First Days of Supernova 1987A

July 1987: Science at McDonald Observatory, Old and New Views of Solar Prominences, Photographing the Southern Sky, The Extreme Ultraviolet: A Promising New Window on the Universe, A Portable Photographic Platform

August 1987: The Impending Crisis of Space Debris, The Telescope That Never Sleeps, Watching Earth Move with the Shadow Clock, Prospects for the March 1988 Total Solar Eclipse, Tips for Shooting Clusters and Nebulae, Searching for Supernovae: The Discovery in M-99

September 1987: The Changing Shape of Planetary Rings, Possible Planetary Systems Discovered, Riverside and the Texas Star Party, The Secret World of Dark Nebulae, Simulating Clusters on Your Computer, Observing Comet Halley's Near-Nucleus Features

October 1987: The Geometry of Space and Time, ASTRONOMY's 1987 Guide to Telescopes, 1987 Telescope Buyers' Guide, The Moon on a Silver Plate

November 1987: Aiming at Neptune, Explosions in the Solar Atmosphere, Return to Mars, Jupiter's Best Show in Twelve Years, Build a Heated Dew Cap for Less than $10, SR-V 3200: The Superfilm from Konica

December 1987: How Do Spiral Galaxies Spiral?, ASTRONOMY 1987 Subject Index, The ATI "CAT": The Wave of the Future?, How to Discover a Comet, Taming the Schmidt Camera

---

February 1988: Insight into Star Death, Comet Bradfield Dazzles Backyard Observers, Our Cosmic Horizons Part One, Build a Binocular 'Sky Scanner'

March 1988: Our Cosmic Horizons Part Two, Build ASTRONOMY's Star Time Clock, Capturing the Conjunction of Jupiter and Venus, Make Your Own Black-and-White Prints

April 1988: Digging Deeper for Life on Mars, Our Cosmic Horizons Part Three, Venus, the "Evening Star", The Saturn-Uranus Triple Conjunction

June 1988: Chaotic Material between the Stars, Quest for the Most Distant Objects in the Universe, Saturn Overtakes Uranus, Searching for Supernovae

July 1988: The Soviets Advance into the Solar System, Eclipse Tales from the South Pacific, Ten Pointers for Mars Observers, Filters for Better Astrophotos

August 1988: Cosmic Origins of the Elements, The Pull of Planet X, Forecast for Dust Storms on Mars, Dark Skies for the Perseid Meteor Shower

September 1988: The Difficult Births of Sunlike Stars, Astronomy in Our Schools, Soup Up Your Small Scope, Do-It-Yourself Color Processing

October 1988: The Rise and Fall of the Sun's Activity, Is Stellar Astronomy a Second-Class Science?, ASTRONOMY's 1988 Guide To Telescopes, 1988 Telescope Buyers' Guide **(This issue $2.95)**

November 1988: Mercury's Heart of Iron, William Herschel: Pioneer of the Stars, How To Make Great Astrophotos, The Revolution in Fast Film

December 1988: Exotic Pulsars, Red Planet Roundup, Galaxies from the Beginning of Time, The Triumphant Grand Tour of Voyager 2, Galactic Collisions on Your Computer

---

January 1989: Special 1989 Sky Preview, Returning to Space with Missions to Venus and Jupiter, Astronomy in the Year 2000, Discovery's Cargo of Dreams, Secrets of City Astrophotography

February 1989: Neptune's Mysterious Moon, How to Observe the Sun Safely, Eclipse Prospects for the 1990s, Supernova Aftermath, Legendary Faint Galaxies

March 1989: Secrets of the Sun's Interior, Springtime Galaxies Galore, Build a Martian Volcano, Explore the Moon's Wonders, The Curious Shapes of Cosmic Jets, Your Own Piece of the Solar System

April 1989: Do Brown Dwarfs Really Exist?, Venus Unveiled, Reading the Color of the Stars, The New Generation of Dobsonians, Memories of Mars, The Art of Observing Planetaries

ODYSSEY
TELESCOPES
Seeing the *real* Universe

FREE INFORMATION
- ODYSSEY GUIDE
- OWNER COMMENTS
- REPRINTS
- DOBSONIAN INFO.
- COULTER OPTICAL NEWS
- PRODUCT LIST

ASK FOR IT!

8 inch $239.50

"On the Moon and Jupiter, the Odyssey 8 showed as much detail as several 8" Schmidt-Cassegrains nearby." David McGough, Millington, N.J.

"It is worth twice what I paid, but please don't raise the price. I want to get my son one in a few years." Tom Johnston, Boulder, Colo.

10.1 inch $299.50

"Careful star-testing of the 10.1" Odyssey Compact I received last March and of the 10.1" my neighbor Doug Barnes picked up in mid-October suggests a high level of quality control which is astonishing. Diffraction patterns are virtually interchangeable, and both scopes show textbook optical results (both in-focus and out-of-focus)." Lee Johnson, Coquitlam, B.C. Canada

13.1 inch $499.50

"In amateur astronomy for over 35 years and I have seen my share of all kinds of telescopes, good and bad. To say the least, the Odyssey 1 outperforms any thing that I have seen!!" Richard Ziegler, Maumee, Ohio

"There is not another telescope of equal size in our club that can touch the clear image and ease of operation that Odyssey 1 provides." Mark Davenport, Pinellas Park, Fla.

17.5 inch $995.00

"I've only had a chance to view once so far, but am thoroughly thrilled with it. Viewing from a (Santa Barbara, Ca.) residential front yard, the Orion Nebula was indeed a treat – reddish tinges on the predominating green, with many subtle wisps and lanes very clear. The Andromeda Galaxy was surprisingly bright, as was its companion." David Broad, Santa Barbara, Ca.

Lightweight Mirror Optics at Low, Low Prices:

Pyrex, ⅛ wave, aluminized & overcoated

10 inch f/5.6	$129.50
10.1 inch f/4.5	$134.50
12.5 inch f/6	$249.50
13.1 inch f/4.5	$254.50
17.5 inch f/4.5	$590.00

Elliptical Diagonals

1.83" — $15.50	3.10" — $ 34.50
2.14" — $18.95	4.25" — $ 69.50
2.60" — $22.50	6.25" — $150.00

EASY TO ORDER . . . Phone or mail your order in today. Visa/MasterCard accepted. All telescopes are shipped freight charges collect. All mirrors are shipped prepaid in the contiguous U.S.A. No sales tax on out-of-state orders. Phone orders Mon-Fri 8 am-4:30 pm local time. Call 1-714- 659-4621

- **30 days returnable**
- **30 days exchangeable**
- **2 years materials and workmanship**

Coulter Optical, Inc.
P.O. Box K
Idyllwild, CA 92349-1107
"OPTIMUM OPTICS AT MINIMUM COST SINCE 1967"

OBSERVING AMONG THE SMOKESTACKS

At 3 p.m. my neighborhood is buzzing with lawn mowers, barking dogs, and the clatter of school children walking home. You can't blame them for the noise, because, after all, none of them has to stay up all night, but I do.

I work the graveyard shift as a supervisor in a steel mill in the "rust bowl" of the Midwest. It doesn't take long on the graveyard shift to learn about the need for sleep. If you're not careful, you reach a point where your mind and body begin to function in a fuzzy consciousness that only other nighttime creatures can relate to. I know I need another hour, but it's no use. I roll out of bed.

By evening the clouds that had filled the sky that afternoon have thinned out and the curtain is being drawn back for a splendid show. First-magnitude stars slowly appear as the streetlights begin to blink on. Time to go to work.

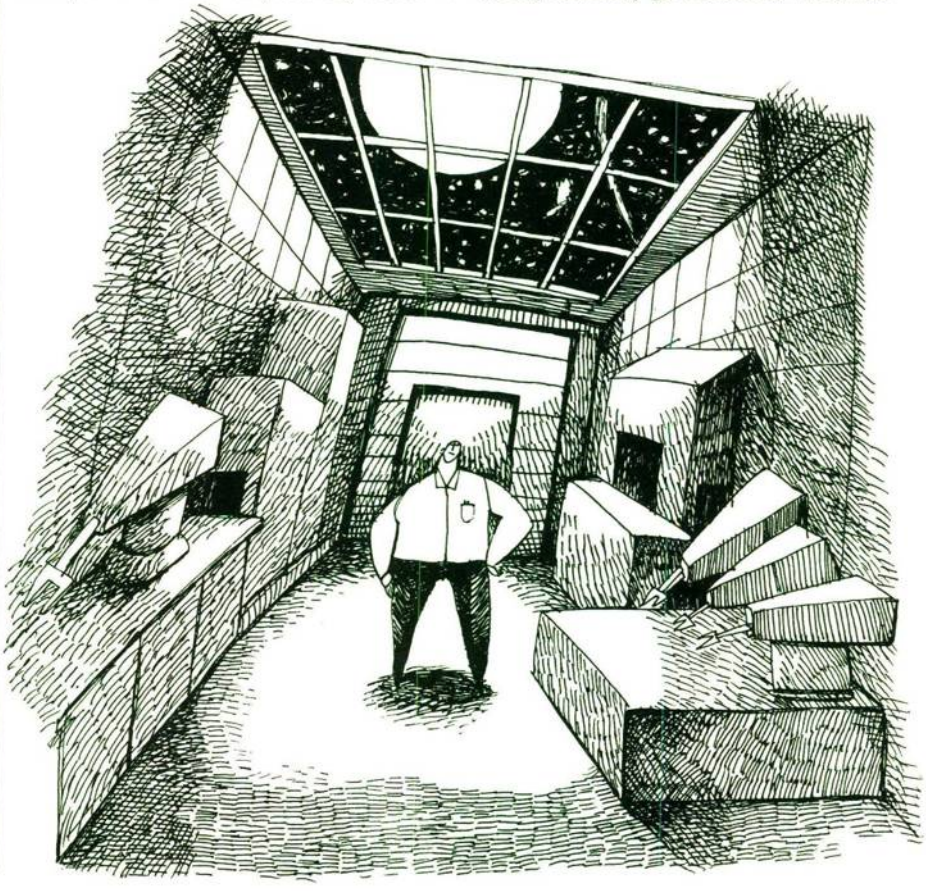
In my car as I turn east toward the expressway, I scan the horizon for Jupiter. The king of the solar system glows just above the tree line. I turn off the highway and head west again. To my left are railroad cars heaped with rusted scrap metal, the skeletons of yesterday's technology, destined for the blast furnace. Above them shines Scorpius, and Saturn glows above Antares. Ahead the horizon is obliterated by light from an oil refinery, its towers ablaze. I arrive at the parking lot, my last chance to view the whole sky before going inside.

There is much to set up and get ready. Computers are cranking out a summary of yesterday's activity, and once that's completed, I take a half hour to set it up for tonight. I get an update on the condition of the machinery and review the night's priorities.

I make a round on the floor to be sure everything is in order and that everyone understands his or her assignment. By midnight the whole operation is on-line and I have time to look at the sky.

I step out of my office and look up through a fifteen-by-twenty-five-foot opening in the factory ceiling. Jupiter is rising above the superstructure of an electrical substation.

The heavens give me their wonder and majesty in a very dreary place. My observing time is always brief; I'm not getting paid to stand outside gawking at the sky. I usually go out four or five times



a night, every night, to be carried away from this place for a few brief moments.

My eyes behold the Summer Triangle, the Winter Hexagon, the planets playing tag with the Moon as it goes through its phases. I watch and I wonder and I never grow tired of the beauty. The sky is not wasted on this secret observer. It's an oasis that refreshes my spirit in a landscape where smokestacks outnumber trees.

The night creeps on and I poke my head out the door for my last observing session. Jupiter is to the west now. Taurus and the Pleiades are climbing in the east, though the Seven Sisters are seldom visible from this location. Even as a faint glow they are a feast for eyes wearied by acres of artificial lighting.

Six a.m. rolls around and the day crew saunters in. I fill in my relief on the status of the shop. He asks if anything happened. My brain is divided: I hear my voice tell him about breakdowns, quotas, and production, but my mind is reviewing a night filled with events that I may never fully comprehend. It was one of the best nights of seeing ever witnessed from my observatory. — *George Coburn*

THE MAGIC OF AN OBSERVATORY

For many years my stargazing had been limited to lying in the backyard on summer nights, pointing out Ursa Major. But that changed after I had the chance to observe at several observatories. I've discovered that there's magic every time an observatory dome opens up on the night sky.

My first observatory experience came twenty years ago in a little college town near Cleveland. A friend of mine was in charge of the college observatory, and he invited me over for a viewing. Everything about that experience seemed out of the ordinary. I remember a great padlock on the observatory door and a big, old-fashioned key. Just taking the keys out of his pocket to unlock the building was a ritualistic gesture.

Once we were inside, the dome groaned as it opened to reveal a wider and wider section of dark, star-filled sky. The echoing old dome and the alchemist-like magic of the one who can open up the skies has remained with me and grown over the years.

Two years ago I visited two Colorado observatories within a week. One was a relic. I had to climb a tall ladder and peer into the eyepiece while a line of prospective viewers wound through the darkness below me. A few days later I visited a more modern university observatory where our guide called forth a brilliant Arcturus right out of a bright blue daytime sky.

And now I have spent an entire night with the 30-inch telescope at McDonald Observatory on Mount Locke in southwestern Texas, and I am hooked. That spring night I was part of a lucky group of viewers that inched its way up the mountain, laden with warm clothes and snacks. We were unable to see one another as we stepped past the bunker-like dome of the 36-inch telescope and entered our own little spaceship.

Again I heard the creak and groan as the roof slowly turned and opened. The computer-driven telescope hummed as it took orders and turned to poke its great eye through the dome. Our eerie silhouettes were flattened around the walls. We saw one another only in occasional red-filtered light and in the dim numbers of the computer screen.

One by one we scaled the ladder. We became rigid with cold as the wind swirled through the observatory and we looked into the heavens again and again. As dawn approached, my eyelids drooped in weariness. My eyes no longer saw brilliant Saturn, the fuzzy galaxies, the smudges of nebulae, the brilliant double stars, the lovely clusters. I saw patterns of triangles, brown against black, a result of eye fatigue. And still I wanted to stay there, to hear the dome turn and see the telescope follow its lead.

More than halfway through the night our guide opened the lower flap of the dome slit, accompanied by clanks and metallic squeals. The wall opened and in poured the universe, the Milky Way tossing its light upon us.

The Ring Nebula, the Whirlpool Galaxy, Neptune, Uranus. I had seen most of these objects before. But when I viewed two distant galaxies, I knew I was a part of creation, not just an onlooker.

When we left the observatory, fog filled the valley below us, and as we made our way down the mountain, the dome at the top was white against the approaching dawn.

Perhaps if there were an observatory on every corner I would not be so enchanted. Perhaps if I had become an astronomer as I had dreamed as a child, the experience would have become "ho-hum" by now. But I don't think so. I don't believe the magic ever fades. I would still be there, anticipating the approaching darkness, experiencing the primitive excitement as the heavens open their secrets through a manmade crack, and as I set sail, again and again, through the night. — *Carol Hamilton* □

Harvard

COSMIC RAYS
Michael W. Friedlander
Friedlander's engaging tale of this peculiar rain of charged particles begins with their discovery early in this century and goes on to describe impressive attempts by a special breed of scientists—sometimes engaged in swashbuckling science at its most adventurous—to fill in the gaps in our knowledge. Friedlander touches the astronomer within each of us who yearns to explore one of the great mysteries of the universe.
$27.50 cloth

DARKNESS AT NIGHT
A Riddle of the Universe
Edward Harrison
"The night sky is dark. The question is why...Mr. Harrison has an answer, but to state it here seems as unfair as giving away the final chapter of a mystery story. Better to read his book."
—Timothy Ferris,
New York Times Book Review
$12.95 paper/31 halftones, 49 illustrations

THE COSMIC INQUIRERS
Modern Telescopes and Their Makers
Wallace Tucker and Karen Tucker
"[This is] a unique book that lets the reader peer behind the scenes to meet the personalities involved in the most exciting astronomical projects of the late twentieth century."—David A. Dundee, *Explorer*
$10.95 paper

Available at bookstores or from
Harvard University Press
79 Garden Street, Cambridge, MA 02138
(617) 495-2480

Astronomy Software

High Quality Software! Great Prices! Pick the Ones You Want:

AstroCalc™ - Input time/date & your lat/long and get for Sun, Moon, & all planets: Right Ascen/Dec, Alt/Azm, Ecliptic Lat/Long, Angular Size, Fraction Illum., Elongation, Orbital Elements , Rise/Set Times, Brightness, Distances from Sun & Earth. Also provided are: Local Sidereal Time, Greenwich Sidereal Time, Solar Equation of Time, Twilight Start/End. Heliocentric & geocentric data. **Thousands of satisfied users.** IBM, Apple II, C64/128 **$29.95**

AstroCalc Plus™ - All features of AstroCalc basic version plus: Automatic repetitive calculations (solar/planetary positions or any other data for every hour or day, etc.). Output as ASCII file for use in wordprocessor, etc, or printed output. Visual displays with RA/DEC views, Alt/Azm. views, heliocen. or geocen. overhead views. Greater selectivity of output options & more! Configuration startup file saves location, time zone,etc. IBM & compat **$59.95**

Gravitator™ - Calculates gravitational forces on astronomical bodies such as stars & planets & determines their orbits. See paths plotted & vary scale of view, orientation & angle of view. Input any set of initial conditions, use examples provided or get random sets of clusters. Save systems created to run later or try new conditions. Vary time factor to speed up/slow down simulation. Manual with theory/use. IBM & compat., CGA /Hercules graphics**$39.95**

LodeStar™ - Get accurate, variable size views of the sky for any date & time from 9999BC to 9999AD. Includes over 9,000 stars, Messier objects & Sun, Moon & all planets. Choose any size view from 180 deg. to 0.18 deg., with or w/o constellation lines. Set limiting mag., option for colored stars & size proportional to magnitude. Sun, Moon & planets show actual size & phase at high magnif. See solar eclipses, planetary conjunctions, occultations, transits, etc. Scroll to any object/zoom in or out. Identify stars/objects & get RA/Dec, Alt/Az, Rise/Set & transit times. Calculates refraction, precession , Gregorian & Julian calendars. Get printout of displays w/ graphics printers. IBM or compat., 384K, CGA/EGA/VGA. Works with or without co-processor. **$89.95**

SunTracker™ - Calculates solar eclipse for any date & displays a world map with areas of visibility. Provides dates of eclipses and elements, accurate to 12 miles on Earth's surface. Or input elements to achieve greater accuracy; with EclipseMaster data, accuracy is within 1-mile. Central line of eclipse is plotted on world map & limits of visibility for partial eclipse, which can be specified. Tabular data includes central line location, width, duration of totality & altitude of Sun. IBM w/ CGA, Apple II, C64/128 **$29.95**

EclipseMaster™ - Computes solar & lunar eclipses within 1-mile accuracy for central line, 1/20 of 1% magnitude. Accurate to 3 sec. of arc in longitude & 1 sec in latitude. All aspects of eclipse calculations: central line, local circumstances, area of visibility, duration, width of central line, finding of eclipse seasons for any year. Computes occultation of a star or planet. IBM, Apple II, C64/128 **$29.95**

AstroFinder™ - Night sky realistically simulated for your date/location. Choose any azimuth (0-360 degrees) on your horizon. Print star charts in 4 formats. Manual with star atlas; 30 page star catalog. All Messier objects, deep-sky objects file, add more. Planets & comets tables. IBM & compat. with CGA/EGA, graphics printer. **$59.95**

Astro-Aid™ - 44 astronomical functions: Coordinate Conversions: Equat., Ecliptic, Galactic, Alt-Az; Time Conversions: Julian Day, Greg., Sidereal, UT, ET, Solar; Precession, Nutation, Aberration, Parallax, Refraction; Kepler's/Newton's Laws, Telescope Design, Equinox/Solstice times, Polaris Transits, Jupiter's moons; Solar System Data: Sun, Moon, Planets, Satellites; Constellations: Names, Areas, Primary Stars, Lore; Stars: Nearest, Brightest, Positions, Names. Manual. IBM, Apple II, C64/128 **$29.95**

AstroTutor™ - Introduction to all of astronomy, the human side - history of astronomy & astronomers ancient & modern - & the technical side, solar system & planets, stars & their evolution, galaxies and methods of astronomy (observing, telescopes, etc.). For anyone interested in astronomy, student, amateur. Uses graphics & animation to illustrate key ideas.IBM & compat. CGA/EGA/VGA **$39.95**

AstroStell™ - Teaches all 88 constellations plus deep sky objects. Includes: Call constellations by name to screen, Random display to guess names, Names & magnitudes of bright stars, Deep sky objects(galaxies, star clusters, nebula, double stars), Classical lore. Input date/time, & get constellations visible. History of constellations & star charts. Observing tips & using a telescope. IBM, Apple II **$29.95**

Do you have a professional quality original program? We may want to publish it. Write for our programmer's guidelines. Please do NOT send any software or program descriptive materials at this time.

Plus 43 More Excellent Programs!

Order Today!

1-800-533-6666

9-9 MON - SAT Orders Only
For Info or in PA Call 412-422-6600

By phone or mail. Check, M.O., credit card(#&expir.). Add $3 shipping($5 overseas). PA add 6%. Give computer type. Add $1/prog. for 3.5"IBM. Join tens of thousands of satisfied customers in 50 states & 86 countries. Fast shipment!

ZEPHYR SERVICES

The Leading Publisher of Astronomy Software

1900 Murray Ave. Dept. B
Pittsburgh, PA 15217
FREE Catalog-Call or Write

Our 8th Year

MORE THAN SOLAR SYSTEM DEBRIS

Introduction to Asteroids by Clifford J. Cunningham, (Willmann-Bell), ISBN 0-943396-16-6, paperback, 208 pages, $19.95.

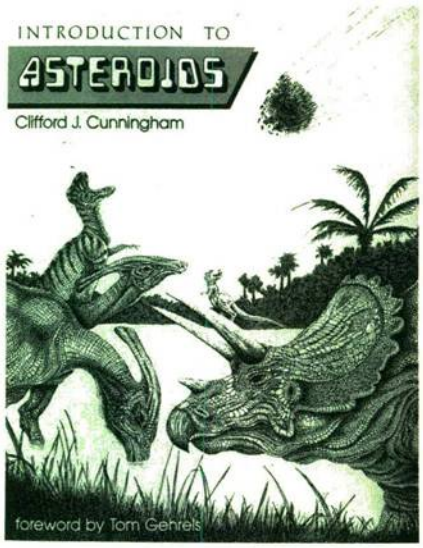
When many of us think of asteroids, we simply envision a bunch of rocks flying around in space in an eternal orbit somewhere between Mars and Jupiter. And yet these rocks rattling about in the solar system are more than just space debris. They are puzzle pieces, each holding answers to questions bigger than themselves. As Clifford Cunningham says in his introduction, asteroids may hold the key not only to the origin of the solar system but to evolution, paleontology, geology, and "even the nature of time itself."

Introduction to Asteroids is directed at the undergraduate astronomy student and the advanced amateur astronomer; it speaks authoritatively to both audiences. An astronomy professor may wish to use it as a text for an undergraduate class, while amateur astronomers may use it as a significant addition to their observing routine.

The book contains nineteen chapters that discuss such topics as investigative methods, asteroid composition, orbital characteristics, families, shapes, and space law to name but a few. Cunningham opens with a comprehensive discussion of the history of asteroid studies and the push in the late eighteenth and early nineteenth centuries to look for "missing planets" among the stars. By 1850 so many asteroids had been discovered that professional astronomers stopped looking for them, believing that the list of minor planets was complete and that the rate of discovery couldn't possibly continue. The search for asteroids after the mid-1800s, Cunningham points out, was left largely to amateur astronomers.

Of all the chapters, three stand out for the cogent way in which they relate current information. One chapter is devoted to the current scientific debate on the possible demise of the dinosaurs as a result of an asteroid or comet impact. Another chapter contains a comprehensive collection of data on the taxonomy of asteroids. The author has also devoted a chapter to setting up an asteroid observing program that many amateurs will welcome.

As a matter of style Cunningham begins each chapter from the historical perspective before moving into the main topic. Within each chapter he has done an admirable job of providing elementary



explanations of the historical and current methodologies, tools, and techniques utilized in the study of asteroids as well as other branches of astronomy.

The book features a generous number of graphs, histograms, charts, and tables. A couple of these, however, portray concepts in so small an area that the tiny type within the graphics is difficult to read. While in general I admire the work of Willmann-Bell as a publisher, I can think of better ways to keep production costs down other than restricting the size of the visual material and requiring the reader to keep a magnifying glass close at hand. Minor complaints aside, the graphs and tables throughout the book are well chosen to simplify the material and represent a wide spectrum of asteroid research.

Throughout the book Cunningham frequently refers to various authorities and personages, but, unlike other writers, he has taken the time to provide a brief biography of each of these individuals in his final chapter. A glossary of some of the more specialized terms is also included for the reader's convenience. For those not familiar with the mathematical expressions, Cunningham has thoughtfully provided an elementary explanation of each of the terms used. Regrettably he did not include them in a standard table in the appendices. This is somewhat of a nuisance because these terms crop up later in the text. If the reader has forgotten the meaning of a term, he has no recourse but to sift back through the text looking for the first reference.

In addition to the bibliography, there is

also an appendix that not only provides additional reading suggestions but also sources for active, ongoing material relevant to the study of asteroids. This will be particularly useful to anyone who wants to formulate an observing campaign.

Without doubt *Introduction to Asteroids* will become a cornerstone for mounting pursuits in the field of asteroid studies for both amateur and professional astronomers. — *Richard Stanton*

HANDY REFERENCE FOR DEEP-SKY OBSERVERS

NGC 2000.0: The Complete New General Catalogue and Index Catalogues of Nebulae and Star Clusters by J. L. E. Dreyer, edited by Roger W. Sinnott, (Sky Publishing Corp. and Cambridge University Press, 1988), ISBN 0-933346-51-4, paperback, 273 pages, $19.95.

Deep-sky observers have a rough time getting the right information. Much of what exists in the popular literature is drawn from old data, so magnitudes, sizes, and sometimes even positions of objects are inaccurate. The problem stems from the fact that recent, accurate information lies distributed in hundreds of research articles. *NGC 2000.0*, a newly published handbook of data for 13,226 deep-sky objects, fills a long-neglected gap by collecting much of this new scattered information into a single volume.

NGC 2000.0 consists of a tabular listing of the three most important catalogs of deep-sky objects, the *New General Catalogue*, the *Index Catalogue*, and the *Second Index Catalogue*. Originally published as separate volumes at the turn of the century by astronomer John L. E. Dreyer, these catalogs together include virtually all bright deep-sky objects visible with backyard telescopes.

Last printed in 1971, these three catalogs have been hard to find. Now Roger W. Sinnott has compiled the catalogs into a single listing by right ascension and updated their coordinates to equinox 2000.0, which makes them compatible with modern star atlases. In addition Sinnott has included accurate magnitudes and sizes culled from authoritative sources for many objects. The book contains an index organized by right ascension so you can quickly look up an NGC or IC object and flip to its correct place in the list.

Adhering to the format of the original catalogs, *NGC 2000.0* includes Dreyer's original cryptic descriptions that are somewhat difficult to decode (a key appears in the introduction) and add little to an object's description. For example, Dreyer's entry for the Andromeda Galaxy reads "!!!, eeB, eL, vmE." By the time I've decoded it as "a magnificent or otherwise interesting object, most extremely bright, extremely large, and very much extended," I'm wondering what this told me that I didn't already gather from looking at the data. However, because these descriptions are a feature of the original catalogs, it would be difficult to justify dropping the coded descriptions; they have become a part of the character of the NGC over the years.

Sinnott has provided deep-sky observers with a valuable resource. By making the NGC and IC catalogs available once again — and for the first time updated with the most recent data — he has produced a work that will long sit on the bookshelves of deep-sky observers everywhere. — *David J. Eicher*

THE LOCAL UNIVERSE IN THREE DIMENSIONS

Nearby Galaxies Atlas by R. Brent Tully and J. Richard Fisher, (Cambridge University Press, 1988), ISBN 0-521-30136-X, spiral-bound softcover, 28 pages, $49.50. *Nearby Galaxies Catalog* by R. Brent Tully, (Cambridge University Press, 1988), ISBN 0-521-35299-1, hardcover, 214 pages, $59.50.

Although the introduction to the *Nearby Galaxies Catalog* states that the two-volume set was designed to appeal to a wide audience — professional as well as "motivated" amateur astronomers — the atlas is not designed as an observing tool for amateur astronomers looking for galaxies in the sky. Rather, these two works function more as a conceptual aid in understanding the structure of the local universe as framed by nearby galaxies.

No individual stars are mapped, only galaxies. There are no constellations or constellation boundaries; instead the sky is renamed for galactic regions: the North Galactic Pole, the Leo Cloud, the Local Void, and so on. Whereas a star atlas gives you the apparent position of a galaxy on the sky, the *Nearby Galaxy Atlas* plots a galaxy's location in the local universe with respect to how fast it is receding from our Galaxy.

Serious amateurs will find a mass of useful data in both volumes. The catalog, for example, contains morphological information of value to deep-sky observers (magnitudes, diameters, galaxy types, etc.), while the atlas is a graphic representation of galaxy positions. You see how galaxies are strung across the sky in clusters and how members of galaxy groups "stack up" to one another's recessional

Galleria Optics For Land, Sea And Sky

59 THE CIRCLE, EAST HAMPTON, NEW YORK 11937

UNITRON'S UFO'S ARE HERE ☞ 7 X 50 $99.00

and

ASTRONOMICAL OBSERVATION BINOCULARS ARE ALSO HERE!!!

➥ 11 X 80 $210.00
➥ 20 X 80 $245.00

UNITRON'S REFRACTOR TELESCOPE SPECIALS

2" Altazimuth (#105) $350.00
2.4" Altazimuth (#114) $525.00
2.4" Equatorial (#128) $625.00
3" Equatorial (#142) $1,100.00
3" Compact (#131-C) $950.00

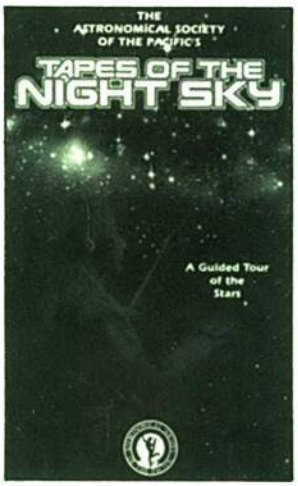
OFFER GOOD WHILE SUPPLIES LAST

4", 5", AND 6" UNITRON TELESCOPES ARE AVAILABLE ACCORDING TO YOUR SPECIFICATIONS.

CALL US AT: 516-822-4691

All prices are subject to change.

Take a Guided Tour of the Stars with the Astronomical Society of the Pacific's TAPES OF THE NIGHT SKY



It's never been easier to explore the wonders of the night sky! Just listen to this cassette tape duo in your portable tape player and you'll have an astronomer at your side, giving you a guided tour of the bright stars and constellations.

By relying on clear, bright stars as guideposts, the TAPES OF THE NIGHT SKY can help stargazers of all ages get to know the sky quickly and enjoyably. Each of the four seasonal tours features basic, easy-to-follow instructions, together with interesting information about the astronomy and mythology of the objects you identify.

With TAPES OF THE NIGHT SKY as your guide, you'll feel like an expert in a matter of hours.

TAPES OF THE NIGHT SKY includes:

- **2 cassette tapes featuring four half-hour tours, one for each season of the year.**
- **A 60-page booklet with clear instructions, full transcripts, and a reading list.**
- **4 seasonal sky maps.**

$16.95

#30181

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. 7th St., Milwaukee, WI 53233-1471. Include for postage and handling: U.S. $1.50; Canada and foreign add 15% (minimum $3). Wisconsin residents add 5% sales tax.

velocities.

The catalog tabulates 2,367 galaxies with known (as of 1978) systemic velocities of less than 3,000 kilometers per second. This limits the catalog to those galaxies within 40 megaparsecs of Earth. These galaxies are plotted on the first ten fold-out color plates in the atlas. Plate 11 is an enlargement of the Virgo Cluster shown on plate 1. Plates 12 and 13 show the galactic clouds plotted in three dimensions to show relative distances from Earth.

The atlas maps are beautiful; galaxies of different recessional velocity are color-coded. Cartographer Jane Eckelman used squares, circles, ellipses, triangles, and cartouches of varying sizes to indicate the apparent angular size and type of galaxy. The galaxies on the first eleven maps are plotted against a light blue background with the galactic coordinate system, in which the fundamental circle is the galactic equator and the zero point lies at the center of the Milky Way in Sagittarius. The coordinates are galactic longitude and galactic latitude, and they are measured in degrees. The zone of obscuration (the Milky Way equator) is illustrated with dark blue shading on the maps.

Most popular astronomy books and catalogs give sky coordinates in the equatorial coordinate system of right ascension (R.A.) and declination (dec). Without the catalog it is difficult to locate a galaxy's location in right ascension and declination on the maps. The catalog lists the equatorial coordinate system (epoch 1950.0), the galactic coordinate system, and the supergalactic coordinate system location (referenced to the local supercluster) for each galaxy. The combination of text and explanatory illustrations clearly shows the user how to get the most out of the atlas.

The catalog consists of three main tables. Table I lists the galaxies and includes a wealth of new data collected by Tully and his collaborators. Table II reorders these same galaxies by grouping them into their associated cluster or cloud. Table III places 382 rich clusters into the five major supercluster complexes and those that fall outside the five complexes.

Preceding Table I is a brief, technical explanation of the information in the table's eighteen columns. Each column can contain as many as three rows of data for each galaxy. Tully's explanations include the sources, reference materials, and formulas used to develop the data. The table consists of such data for each galaxy as its morphological type, diameter, density, axial ratio, blue and infrared magnitudes, various velocities, distances, luminosity, H I (neutral hydrogen) mass, total mass, neutral hydrogen mass to blue luminosity, and the alternative name, if any, for the galaxy.

In comparing the *Nearby Galaxies Atlas* to the popular *Sky Atlas 2000.0* by Wil Tirion, I found a great many galaxies exclusive to one or the other. Tully and Fisher's atlas is limited by galaxy distance (or recessional velocity), while Tirion's is limited by galaxy magnitude. Ironically, the vast majority of nearby galaxies are far too dim for most backyard telescopes. Hence, most galaxies plotted in the *Nearby Galaxies Atlas* do not appear in *Sky Atlas 2000.0*, and vice versa.

This work should become a standard reference source in its field because about two thirds of the observational data collected for this book is original work done by professionals. Though this set may be better suited for the professional astronomer, serious amateurs can gain an understanding of the "shape" and content of the local universe merely by studying the maps and the catalog together. — *Robert A. Garfinkle*

COSMOLOGY

Cosmic Understanding: Philosophy and Science of the Universe by Milton K. Munitz, (Princeton University Press, 1986), ISBN 0-691-07312-0, hardcover, 287 pages, no price given.

The Early Universe: Facts and Fiction by G. Borner, (Springer-Verlag, 1988), ISBN 0-387-16187-2, hardcover, 439 pages, $69.

Large-Scale Structures in the Universe: Observational and Analytical Methods, edited by W. C. Seitter, H. W. Duerbeck, and M. Tacke, (Springer-Verlag, 1988), ISBN 3-540-50135-5, hardcover, 335 pages, $37.10.

SATELLITES

The RAE Table of Earth Satellites: 1957-1986, compiled by D. G. King-Hele *et al.*, (Stockton Press, 1987), ISBN 0-333-39275-2, hardcover, 936 pages, $130.

Satellite Astronomy: The Principles and Practice of Astronomy from Space by John K. Davies, (Halsted Press, a division of John Wiley & Sons, 1988), ISBN 0-470-21174-1, hardcover, 198 pages, no price given.

Satellites International by Joseph N. Pelton and John Howkins, (Stockton Press, 1987), ISBN 0-333-39499-2, hardcover, 265 pages, $190. □

OPEN YOUR EYES TO A WHOLE NEW UNIVERSE!

If you think there must be more to the universe than your telescope is showing you, you're right! With the help of these comprehensive, easy-to-understand astronomy guides, you'll soon become expert in locating those hard-to-find celestial objects from your own backyard.

BURNHAM'S CELESTIAL HANDBOOK: Vol. 1, Vol. 2, Vol. 3. These three volumes are a must for your library! Each constellation has an introductory section with descriptions of double and multiple stars, variable stars, star clusters, nebulae and galaxies. Photographs, tables, graphs, and finder charts are linked by a lucid and fascinating text. Three volumes, 2138 pages in all, paperback. Vol. 1 (Andromeda - Cetus), **$12.50/#30004**. Vol. 2 (Chamaeleon - Orion), **$13.50/#30005**, Vol. 3 (Pavo-Vulpecula), **$13.50/#30006**.

INTRODUCTION TO OBSERVING AND PHOTOGRAPHING THE SOLAR SYSTEM: Dobbins, Parker & Capen. Learn how to observe the planets and how to take your own top-notch planetary photos. This book devotes a full chapter to each planet, plus you'll find a chapter on observing comets, and a chapter filled with helpful hints from veteran astrophotographers on photographing solar system objects. Take advantage of all the observing tips this book has to offer! 224 pages, hardcover. **$19.95/#30172**.

AMATEUR ASTRONOMER'S HANDBOOK, 4th ed.: Sidgwick. An indispensable reference book which includes tips on telescope design and performance, eyepieces, mountings and drives, mirror and lens testing -- as well as data on human vision, the Earth's atmosphere, time and coordinates. 568 pages, paperback. **$10.95/#30018**.

OBSERVATIONAL ASTRONOMY FOR AMATEURS, 4th ed.: Sidgwick. A collection of observing techniques covering the Sun, Moon and all the planets, as well as aurorae, meteors, zodiacal light and double stars. 348 pages, paperback. **$9.95/#30019**.

SKY ATLAS 2000.0: Tirion. Find your way to galaxies, star clusters, and nebulae with ease. These giant star maps are crisp and distinct -- and beautifully illustrated in color. Features 26 charts encompassing both hemispheres, 43,000 stars to the 8th magnitude, 2,500 color-coded deep-sky objects, clearly-defined constellation boundaries, all Messier objects, thousands of NGC objects, and more! **$39.95/#30022**.

MOON MAP. Helps you identify the Moon's anonymous jumble of craters, hills and flat expanses you can see with your telescope. Includes an index and a description of the Moon's original and surface features. Shipped folded in a protective cardboard cover, it can be mounted easily for display. 20" x 29". **$5.95/#30068.**

THE BEST DEEP SKY OBJECTS. This handy card (varnished for durability) shows where all the Messier objects are in the sky -- plus the 51 best objects in the *New General Catalogue*. The front side displays them on an all-sky map; the reverse tabulates each object and gives epoch 2000.0 positions, magnitudes, sizes, observing difficulty, type of object, constellations, and nicknames. 10" x 11-1/4". **$1.50 each or $.50 each for 5 or more/#18029.**

THE UNIVERSE FROM YOUR BACKYARD: Eicher. This is an indispensable and comprehensive atlas of deep-sky objects that you can find and observe from your own backyard. Here are 196 pages filled with color and duotone photographs, maps, sketches, and understandable, crisp text all reprinted from ASTRONOMY's Backyard Astronomer column. Features more than 140 photographs (90 in color), eyepiece drawings, and tips on finding 690 of the sky's best deep-sky objects. It's the perfect guide for all backyard astronomers. **$24.95/#18037.**

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. 7th St., Milwaukee, WI 53233-1471. Include for postage and handling: U.S. $1.50; Canada and foreign add 15% (minimum $3.00). Wisconsin residents add 5% sales tax.

ASTRONOMY SOFTWARE
FOR IBM, APPLE & COMMODORE

- **JOVIAN SYSTEM SIMULATOR** — a Simulation of the Galilean Satellites of Jupiter. (IBM & compatibles) $24.95
- **ASTROVIEW** — Planetarium and database (Commodore 64/128, Apple IIc/IIe 64k/80 columns) $39.95
- Free catalogue of shareware and public domain astronomy & scientific software. Specify IBM or Commodore.

For info write: Andromeda Software Inc.
P.O. Box 1361, Williamsville, NY 14231-1361

Star Hill Inn
an astronomers' retreat in the rockies

Come for a dark sky vacation ... bring your 'scope or rent our 24" cassegrain! Comfortable accomodations at our beautiful 7200' elevation location, wonderful daytime activities in nearby Santa Fe, Taos, and Pecos Wilderness, open year-round.
For free information:
Star Hill Inn, Sapello, New Mexico, 87745
(505) 425-5605

Wanted:
Used telescopes & accessories!!
We offer excellent prices on trade-ins.
For a price quote, call Jeff or Brad.

Call Toll-free:
800-345-4202
or (612) 545-6785

Northern Sky Telescopes
5667 Duluth Street
Golden Valley, Minnesota 55422

Accessories!

Telrad

Ingenious finder with bull's-eye reticle. Images always erect!
Now with DewGuard! **$47.50**
Extra bases...$8.50

Tectron Collimators

These simple devices help obtain improved images from your Newtonian telescope. Three basic tools, plus detailed book. **$95.00**
Sight Tube.....**$29.50**
Cheshire **$38.00**
Auto—Collimator ..**$31.50**
Collimation Book .. **$ 5.00**

STAR TEST
Left: Large Error
Right: Well Collimated

2"-1.25" Focuser

Superb Meade #680 focuser with 1.25" adapter. Perfect for the home-built scope or for upgrade.
$89.95

Illuminated Projection Reticle

Guide with almost any eyepiece! Self-contained illuminated reticle can be moved anywhere in the field! Intensity control, diagonal, and barlow!
.965"...**$141.50** 1.25"...**$163.95**

30 day money-back guarantee. $25 minimum order for free surface UPS in the USA. 3% VISA/MC. Foreign orders welcome. Prompt delivery.

Plus, low discount prices on over 400 name-brand telescopes and accessories. Our "Low-Cost"™ Telescope and Accessory Brochure is free on request. Color catalog package only $5.00.

astro•tech
101 WEST MAIN ■ P.O. BOX 2001
ARDMORE, OKLAHOMA 73402
405/226-3074

ATTENTION ASTROPHOTOGRAPHERS
Focault Focusing Accessory

This unit works on the Focault Principle using an out of focus eyepiece to magnify the star image to a large Disc for easy knife blade focusing using your slow motion controls. Focus your telescope with this attachment every time you Set-up or change filters and attachments, then install your camera for perfectly focused Astro Photos.

Guaranteed or your money returned.
Black Anodized Aluminum **$49.95** ppd.

Send check or money order to:
A.M. PLASTICS
405 Tulip Poplar
Fredericksburg, VA 22401
M/C or VISA Call: 703-373-3919

CANADIANS
WHY PAY MORE?
Free Trade Prices
CALL (416) 783-4140

TELEVUE/CELESTRON/EDMUND/LUMICON
SURESHARP/MOTOFOCUS

Fantastic Meade Values on Schmidt-Cassegrains

2120 LX6
$3360 CAN
2120 LX5
$2795 CAN
2120 LX3
$2499 CAN
2080 LX6
$2750 CAN
2080 LX5
$2350 CAN
2080 LX3
$1995 CAN

WE SHIP ANYWHERE SEND $3.00 FOR NEW '89 CATALOG!

MTS SN6 with 788 Drive, Setting Circles **$925**
MTS SN8 with 788 Drive, Setting Circles **$1099**
MTS C8 with 788 Drive, Setting Circles **$1395**

TELRAD $59.95
B+L 16.3mm Erfle, 1.5" $69.95
C8/2080 Tele Extender $29.95
Set of Six Colour Filters $69.95
B+L 32mm Plossl, 1.25" $59.95
CELSTRON 20mm Erfle, 1.25" $69.95

KHAN SCOPE CENTRE
(Formerly Scope City "Canada")
247 Marlee Ave. Unit 201
Toronto, Ontario, CANADA M6B 4B8

NASA SPACE VIDEOS!

Relive the excitement of Mercury, Gemini, Apollo, and Space Shuttle flights! Official NASA full color sound films on video. Each cassette is approximately two hours long.

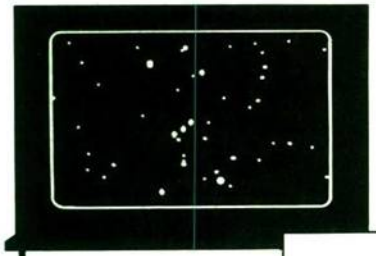
Apollo 8, 11, 15, 17 .....$39
The Early Days—Project Mercury $29
Gemini XII, IV, VI VII, VIII.....$29
Space Shuttle Columbia STS 5,6,7,8 $39
Universe and Space Exploration Earth/Sun, Jupiter Odyssey, Mercury and Mars $29

Special Offer: Any four tapes $120. All 5, $140. Include $4.00 shipping for 1-3 tapes; $7.00 for 4-5. **Express shipping available.**

VISA MasterCard

To order, call toll free
800-437-0800
Unconditional 30 day guarantee!

Hayes & Nolly Productions Inc.
Hayes and Nolly Productions, Inc.
5145 S. Lewiston Way
Aurora, CO 80015



Plot Star Maps on Your IBM-PC!

STARS.BAS STARS.DAT

As a service to its readers, ASTRONOMY is pleased to offer diskettes, for the IBM-PC and its compatibles, containing the STARS.BAS program and the STARS.DAT data file of 1573 stars. This software was described in "How to Plot Star Maps On Your Computer," ASTRONOMY, August 1985. A free copy of this issue will be included with each diskette.

Terms: The cost of the diskette is $29.95. The program is not copy protected, but is copyrighted software. Neither the program nor the data file may be used for commercial purposes, nor may it be re-sold. While we cannot guarantee that the program will work with your computer's BASIC, if the diskette is defective, we will replace it when you return the original defective diskette to us.

#18027

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 1027 N. 7th St., Milwaukee, WI 53233.

Include for postage and handling: U.S. $1.50; Canadian and foreign add 15% (minimum $3). Wisconsin residents add 5% sales tax.

STARS.BAS/ STARS.DAT diskette
$29.95

BUY THE BEST: MEADE—FROM MIKO!

OVER 30 YEARS SERVING SATISFIED CUSTOMERS LIKE YOU!

CALL FOR MIKO"S UNADVERTISED MONTHLY SUPER SPECIALS: (213)394-3221

AUTHORIZED MEADE DEALER

FAST DELIVERY

LX6 MEADE WIDE-FIELD

EXCLUSIVE F6.3 OPTICS MICRO PROCESSOR CONTROLLED

2080 LX6 - $1899
2120 LX6 - $2499

MEADE CAT COMPUTERIZED

AT LAST! FIND OVER 8000 OBJECTS PLUS PLANETS!

For all 2080's and 2120's - $999

LX5 8X SCAN

ELEVEN EXCLUSIVE MEADE FEATURES! ASK US!

2080 LX5 - $1599
2120 LX5 - $1995

SUPER VALUE

The Orig. 2080 Standard w/the World's First Worm Drive in a Commercial SCT!

2080w/wedge & tripod..... $999

MTS MODULAR

MEADE PERFORMANCE! GREAT PRICE! WITH #788 OR LX3 DRIVE

MTS-SN6 W/788 - $699
MTS-SN8 W/LX3 - $949
MCOG ADD - $50

LX3 BLOW-OUT

ONE OF THE WORLD'S BEST BARGAINS! Limited Quantity

2080 LX3 - CALL
2120/LX3 w/#36- CALL

MEADE LX6 Access.

CAT for LX6 ..... $999
Dig. Readout System $399
#39 Dec. $99
#1200A Electric Focuser $179
Color Filter . ea.$16.50
O. A. Guider Sys. $199
Ctr. Wt. Sys. $109
Eyepc. Hldr. 1¼" . $39
Telecmpress. Sys. $79

MEADE CAT/DSC

#9000 CAT for all 2080's $999
#9001 CAT for all 2120's $999
#9003 CAT for C8's $999
#9005 CAT for C11's $999
CAT-COM option ..... add $180
DIGITAL SETTING CIRCLES $399
Please specify scope brand and model

MEADE LX5 Access.

#39 Dec. $99
#1200A Electric Focuser $179
Access. shelf $29
Piggy Mt. $49
Color Filter . ea.$16.50
O. A. Guider Sys. $199
Ctr. Wt. Sys. $109
Eyepc. Hldr. 1¼" . $39
Telecmpress. Sys. $79

MEADE MTS-SC/SN Access.

66A/38M(SC8) ... $159
Setting Cir. $39
#43 DC/RA Axis .. $99
#62 TA $49
Piggy Mt. $49
Dust Seal $49
Nebula Fil. 908 ... $69
140 Barlow 2X ... $79
47 M DA/DC $299
66 A/38 M (SN8) . $189

MEADE MTS-SC/SN Access.

6x30 VF $59
8x50 VF $99
8x50 PVF $149
1¼" BasicT-A $49
Var. Proj. T-A $59
4mm or 1¼ $59
6mm or 1¼ $59
12.5mm or 1¼ ... $59

MEADE LX3 Access.

#36 D.C. $99
#38 Dec. $99
Map Lite $20
Dew Cap $79
Neb. Filter #911 . $139
#62 TA $49
Dust Seal $59
Telextender $49

MEADE 3.1" PLANETARY

312 Alt/Az - $499
#323 Equat. - $549

16" NEW DEEP-SPACE

Built upon request

Ask about Seal Master ball bearings

DS10A - $949
DS16A - $1799

4.5° WIDE-FIELD

MEADE GIANTS

11x80R - $299
20x80R - $349
11x80 - $249

SP 52° AF

MEADE Ser. 4000 5 Element

6.4, 9.7, 12.4, 15, 20, 26, - $79
32, 40 - $99
56, 2" SP - $165

SW 67° AF

MEADE Ser. 4000 6 Element

13.8 - $119
18.0 - $129
24.5 - $145
32, 2" - $209
40, 2" - $269

UW 84° AF

MEADE Ser. 4000 8 Element

4.7 - $135
6.7 - $169
8.8, 1¼/2" - $199
14.0, 1¼/2" - $229

MIKO

TELESCOPES, BINOCULARS PHOTO, AND ELECTRONICS

1259 Santa Monica Mall, Santa Monica, CA 90401

30 DAY MONEY-BACK GUARANTEE!
INTEGRITY YOU CAN TRUST! WE GUARANTEE YOU'LL BE DELIGHTED OR YOUR MONEY BACK (LESS FREIGHT). TRY US!

ASTRONOMY EDUCATOR

School Year Opens with Neptune Flyby

New PBS Series "The Astronomers" Planned for 1990

ATTENTION SCIENCE TEACHERS!
Introducing the Ultimate Teacher's Aide
THE ASTRONOMY EDUCATOR

Now the highly respected science magazine, ASTRONOMY, brings you an informative, useful new educator's edition – the ASTRONOMY EDUCATOR. This unique new teacher's guide can be your complete source for astronomy education news, information, and ideas.

Published nine times a year as a supplement to ASTRONOMY, the ASTRONOMY EDUCATOR brings you news on astronomy and space education, a forum of ideas from astronomy educators like yourself, an activities section designed by astronomy educators for use in your classroom – complete with a teacher's guide to the topic of the month and handouts for your students – and a teacher's resource section devoted to telling you what's new, and who's who in the field of astronomy education.

Subscribe today and receive ASTRONOMY -- and the ASTRONOMY EDUCATOR – for just $29.95. You'll receive a full year of ASTRONOMY and nine informative editions of the ASTRONOMY EDUCATOR.

YES! I want to receive the ASTRONOMY EDUCATOR
Please check the appropriate boxes and complete this form.

❑ Enter my new 1-year subscription to ASTRONOMY, including nine editions of the ASTRONOMY EDUCATOR.

❑ Please bill me $29.95 ❑ My check/money order is enclosed.

❑ I would like to receive the ASTRONOMY EDUCATOR with the remainder of my current ASTRONOMY subscription. I also wish to renew my subscription to ASTRONOMY and receive the ASTRONOMY EDUCATOR for the following year. Please bill me $1 for each edition of the ASTRONOMY EDUCATOR I'll receive during my current subscription, and $29.95 for the following year of ASTRONOMY, including nine editions of the ASTRONOMY EDUCATOR.

A0076A

NAME _____

SCHOOL _____

STREET ADDRESS _____

CITY, STATE, ZIP _____

Foreign subscription price including THE ASTRONOMY EDUCATOR: $38.95. ASTRONOMY is published 12 times per year. The ASTRONOMY EDUCATOR is published as a supplement to ASTRONOMY magazine nine times per year. (September through May)

Need more information? Give us a call at 414-272-2060 and ask for Customer Service.

ASTRONOMY Magazine and the ASTRONOMY EDUCATOR – teaming up to bring you more of what you need to teach the future

NEW ITEMS! Model 50 support unit is now available with universal mount and is adjustable for up to 10 x 50 binoculars. Soft sided binocular cases protect binoculars mounted on supports. CELESTIAL INNOVATIONS, HCR Box 3228, Oracle, AZ 85623 (602) 896-9109. Dealer inquiries welcome.

"TRIP THE LIGHT FANTASTIC"

The 94mm f/7 BRANDON Apochromat has a hand-corrected Christen triplet lens which provides color-free pinpoint star images against an incredibly pure black sky background.

To find out how you may acquire what many are calling the best portable telescope ever made, please phone or write today.

VERNONscope & Co.
Owego Rd., Candor, New York 13743
607-659-7000

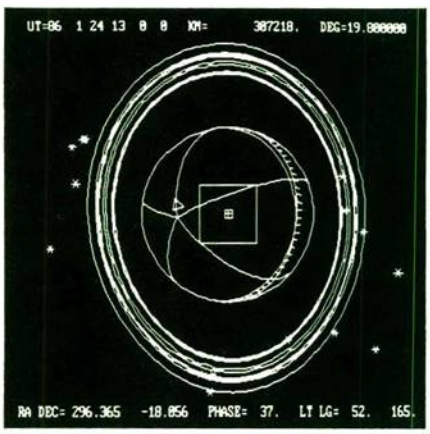
SIMPLE VOYAGER SIMULATOR

XonVu, (XonTech, Inc., 6862 Hayvenhurst Avenue, Van Nuys, CA 91406), $79.

XonVu runs on an IBM PC, XT, AT, or compatible with 512K RAM, one disk drive minimum, DOS 2.0 or higher, and CGA, EGA, or Hercules graphics. (The EGA board must have 129K RAM fitted.) The program is supplied on two 5¼-inch diskettes or (on request) one 3½-inch 720K microdiskette. If an 8087 or 80287 co-processor is installed, the program will use it, but it will also run without one. The program occupies 414K RAM when loaded.

Dark adaption has always seemed a little magical to me. You step outside and look up to see a handful of dim stars. A quarter of an hour later, however, you realize that the sky is literally dusted with stars — grains of sand on a beach. You wonder why you didn't see them before.

XonVu is a bit like that. When you first read the manual, *XonVu* doesn't seem particularly impressive, but the deeper you examine the package, the more it becomes apparent that here is real power hidden under a Clark Kent-ish exterior. It's a pity that like Clark Kent with Lois Lane, *XonVu* hasn't made the final move that lies so near.



***VOYAGER 2* AT URANUS**, as displayed by the *XonVu* mission simulator.

XonVu (pronouced ZON-view) is a program that simulates the outer solar system as seen from the *Voyager 1* and *2* and *Giotto* spacecraft from various points in space or from Earth. The program was originally developed at the Jet Propulsion Laboratory to help analyze science and optical navigation data.

Seven "missions" are available. These are *Voyager 1* at Jupiter and at Saturn and *Voyager 2* at Jupiter, Saturn, Uranus, and Neptune, plus *Giotto* at Halley's Comet.

I ran *XonVu* on three machines: a 4.77 MHz PC/XT with CGA display and 512 K RAM, a 10MHz PC/XT with Hercules display and 640K RAM, and a 10 MHz PC/XT with EGA, 8087-1 co-processor, and 1024K RAM.

On the first machine it took a long time to generate the displays and I don't recommend this configuration for impatient users. In addition, there is no color available on the CGA display, because *XonVu* uses the high resolution black-and-white mode.

On the second machine, *XonVu* ran a little better and the display was a little clearer. There was still a long delay involved in waiting for the graphic screens to appear because there are huge amounts of mathematical data to be processed.

To really show off *XonVu*, you need a machine like the third. The 8087 co-processor really speeds up the graphics screen generation and the EGA display is just superb. The stars are color-coded according to spectral type, planetary rings are colored, and moons are given arbitrary colors to help you identify them easily.

XonVu shows the sub-solar point for each object (the point on the object where the Sun lies directly overhead), draws the terminator, the equator, and a five-line longitude grid; lines of longitude that lie below the horizon are removed so you have the impression of looking onto a solid surface.

XonVu's graphics have a small but disturbing unclarity: when two line elements conflict with each other, the program does not decide which one to keep. Instead it retains both, and the overlapping elements sometimes give rise to strange hieroglyphics.

The manufacturer claims high accuracy for the motions of the bodies, with errors of no greater then 100 kilometers. Oblate bodies display their true shapes, according to the program's creators. All in all, the graphics are pretty good, though the space wire-frame representations are not as inspiring as a fractal landscape. (But then you don't need a Cray to run this program either!)

In its present form, *XonVu* is a real diamond in the rough. There are nearly fifty commands available, which provide

a lot of flexibility in using the program. Their descriptions are sprinkled through the manual and shown on the help screens, which unfortunately are not very helpful. You issue these commands by punching alphanumeric and punctuation characters from the keyboard — no use has been made of the PC's function keys.

Certain program states require you to hit a key to continue the program execution. But despite a message that says, "Hit any key to continue," *XonVu* will not accept the return, space, tab, escape, backspace, and some alphabetic keys to continue the execution. Awkward.

The manual and help screens lack a simple hierarchy chart, which would go light-years toward clarifying the command structure. Something else that would be extremely useful is a system of pull-down menus because all the commands can be grouped into about six categories.

The manual itself is a bit sparse. Its most useful feature is a walk-through of *Voyager 1* at Jupiter. It could contain a lot more. There is an interesting appendix containing data about the *Voyager* craft, *Giotto*, Halley's Comet, and the members of the outer solar system.

In summary, *XonVu* has some fantastic attributes but needs some more polishing to appeal to a wider audience. — *Mike Krochmal*

VOYAGER *VIDEO*

***Voyager 2* at Uranus videotape** by the Jet Propulsion Laboratory, (Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112), 30 minutes, booklet, VHS format, $34.95.

This half-hour video by JPL focuses on the 1986 flyby of Uranus by the *Voyager 2* craft. Narrated by JPL scientist Al Hibbs, the video begins in Bath, England, where it tours William Herschel's house and workshop and shows a replica of the 6-inch telescope Herschel used to discover Uranus in 1781.

Then you are whisked to Pasadena, California, where Hibbs interviews *Voyager* scientists Ed Stone, Larry Soderblom, and Rich Terrile. Stone tells us about one of the unexpected discoveries that came out of the flyby, Uranus' bizarre magnetic field. Soderblom, a geologist, takes Hibbs (and the viewer) on a tour of the five moons of Uranus. Finally Rich Terrile explains a bit about the puzzling ring system.

Reminiscent of many PBS shows, the video is nicely done, though I suspect astronomy educators may go for it more than the general space-interested public will. For my part, I could have wished for

The Best from Meade TeleVue & Celestron!

Meade LX5 and LX6 8 and 10"

Call Toll-Free for our low Meade Prices!

Celestron Ultima 8, Classic, & Powerstar

Call Toll-Free for our low Celestron Prices!

Genuine Meade Acc'ys

Accy case 5o	$79	Off-axis syst	$169
Accy case 54	22	Piggy brkt 8"	34
Dec 38 LX3	99	Piggy brkt 10"	34
Dec 39 LX5	99	Sky/dust seal	49
Dig readout LX6	329	Set circle illum	44
Elec foc 1200	159	Star diagonal 2"	199
Elec foc 1200A	149	Tele extender	37
Filter set of 6	84	Tele comp syst	69
Filter set of 10	149	T-adapt-std	37
Illum EP 419	99	T-adapt-vari	59
LED map light	29	T-mt.-non AF	14
Lenshood 8"	59	T-mt.-AF	19
Lenshood 10"	94	Vari pol 905	49
Nebula 1-1/4"	69	Weight set 8"	94
Nebula 2"	109	Weight set 10"	99
Nebula rear-cel	119	WFAS	119

Mention this ad for *FREE* shipping!

More Celestron Stuff!

C90 II outfit	$399	Elec focuser	$90
C90 II MC outfit	439	Filter set of 6	79
Super Pol C8	1049	Filter set of 10	129
Powerstar Dec	99	Dewstar shade	20

MotoFocus & MotoDec for Meade and Celestron!

Fully compatible with all mfr. hand controls!

Electric Focus with variable speed! To fit LX2/3/5/6 $92

Electric DEC with variable speed! To fit LX3/5/6 $85

Solar Filters in stock!

Highest quality, safe, Type II glass!

4" $79 6" $109 8" $129 10" $139

Mention this ad for *FREE* shipping!

More Meade Stuff!

97E outfit	$379	323 Refractor	$499
97ER outfit	399	SN6 Dlx pkg	769
226 Refractor	159	SN8 Dlx pkg	1099
228 Brass	379	2045	call
291 Refractor	319	11x80 Giants	299
312 Refractor	459	20x80 Giants	309
314 Brass	799	11x80 Rubber	319

Mention this ad for *FREE* shipping!

Konica ASA 3200 Color Film!

Assures shortest possible exposure times without the inconvenience and expense of Hypering!

Five (5) 24exp. rolls $31

Mention this ad for *FREE* shipping!

Meade Eyepieces/Barlows

Ultra Wide		***Super Plossl***	
4.7mm	$139	Up to 26mm	$79
6.7mm	169	32/40mm	109
8.8mm	209	56mm	175
14mm	239	***Super Wide***	
Series II Ortho		13.8mm	125
4/6/9/12.5mm	52	18mm	139
Barlows		24.5mm	149
122 1-1/4" 2x	49	32mm	219
140 1-1/4" 2x	74	40mm	279

Mention this ad for *FREE* shipping!

TeleVue Eyepieces

Plossl		***Naglers***	
Up to 26mm	$70	4.8mm	$134
32/40mm	85	7mm	164
55mm w/guard	194	9mm	199
Wide Field		11mm	209
15mm	119	12mm Type2	219
19mm	126	16mm Type2	249
24mm	139	20mm Type2	309
32mm	199	***Barlows***	
40mm	269	2.5x 1-1/4"	74

Mention this ad for *FREE* shipping!

Our 74th year providing the finest service!

Send $1 postage for a 2-yr. subscription to our GIANT 64-PAGE *buying guide! All products include full factory packaging.* Prices listed include UPS ground in continental U.S. Always call for current stock/price info–ads are placed 60+ days prior to publication!

Visa, Mastercard, Amex, Check, Cash C.O.D.

SHUTAN *camera & video*

312 W. Randolph • Chicago • 60606
M-F 8:30-5:30 • Saturday 9-5

Call Toll-Free!
800-621-2248
Illinois 312-332-2000

PLANETARIUM INTERNSHIP
Bachelor's degree and planetarium experience required. $11,000 salary plus benefits.
For details write:

Intern Program, Hayden Planetarium
81st Street and Central Park West
New York, NY 10024

An Equal Opportunity Employer

TELESCOPES • BINOCULARS • ASTRO-AIDS
HARVARD CAMERA CENTERS
Harvard Common, Harvard, MA 01451
Tel (508) 456-3100
In Central Massachusetts, your
*KNOWLEDGEABLE
*STOCKING
*DISPLAY DEALER
CELESTRON
MAGAZINE PRICES – HANDS ON SERVICE

METEORITES
AVAILABLE TO ASTRONOMERS, SCHOOLS INSTITUTIONS AND PRIVATE COLLECTORS. STONES & IRON SPECIMENS. **LIMITED SUPPLY.**
ROBERT A. HAAG — METEORITES
Box 27527, Tucson, AZ 85726
— PLEASE SEND $2.00 FOR FULL COLOR CATALOG —
Refundable on first order

Telescopes • Binoculars • Astro-Aids
— Catalogs $3.00 —
We will not be undersold!
PAULI'S WHOLESALE / DISCOUNT OPTICS
29 Kingswood Rd., Danbury, CT. 06811,
Tel. 203-746-3579
Meade

THE COMPLETE SOLAR SYSTEM

Now you can explore the richness and complexity of the solar system on your PC with **Dance of the Planets**™.

Fine graphics and accurate orbital simulation. Planets, satellites, asteroids, comets, all on their Newtonian rounds. Orbital chaos and resonances, perturbed comets, precessing nodes, eclipsing satellites. Colorful Jupiter, majestic Saturn, the pristine Uranus satellite system. And among the stars in Earth's sky, cycles and epicycles that still intrigue.

Support for serious study. Watch past and future events unfold and then switch to information screens for data. Examples: Watch Jupiter capture comet Gehrels in 1970. See why comet Kojima will be a year early in 2000 and where to look. Know ra/dec and distance of asteroid Geographos at close Earth passage in 1994. See where Triton will be at the Neptune-Voyager encounter. This is a model that is open ended. Like the real thing.

Dance of the Planets ™
The Complete Solar System

For IBM compatibles, EGA/VGA (inquire for HGA). 5X faster w/coprocessor. $165 plus shipping. MC/Visa accepted. Literature available. Assured satisfaction.

ARC Software
Box 1974A, Loveland, CO 80539-1974
(303) 663-3223

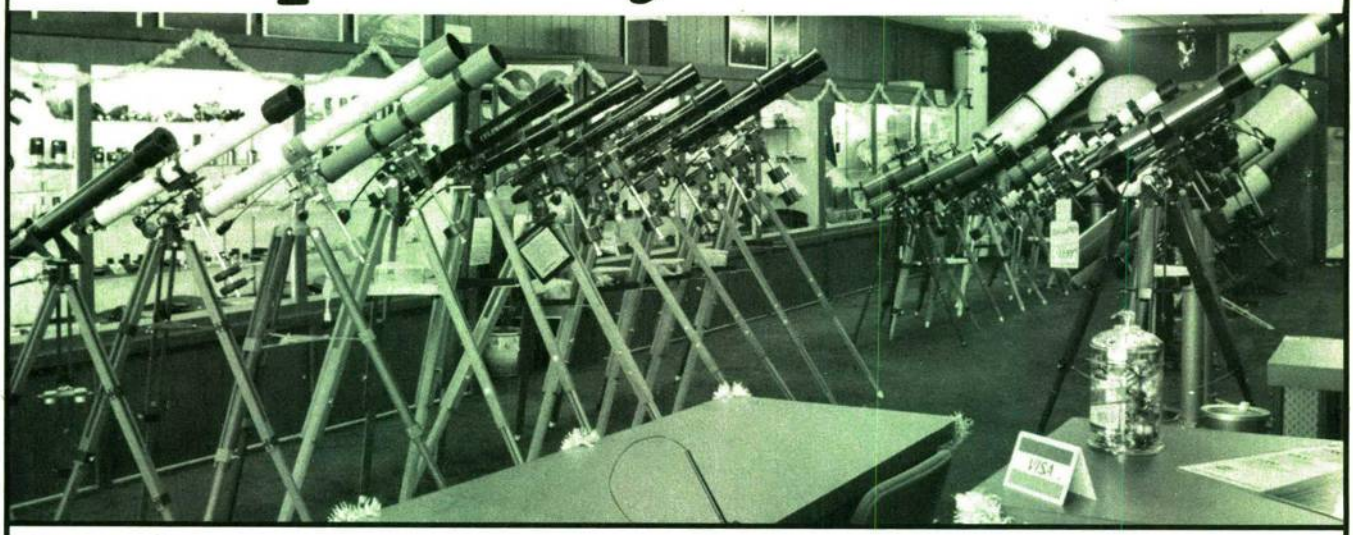
READER EXCHANGE

FOR SALE – Bolex 16mm camera with through-the-lens viewing. Less than fifteen rolls shot. Mint condition. All lenses included. Make offer. Contact Gerald Beilman, 26 Mohawk Circle, Newington, CT 06111.

FOR SALE – 135mm f/3.5 Auto-Nikkor Q with deluxe case and hood. $125. Four 2" optical flats. $25 each. 1.25" star diagonal. $19. 0.965" star diagonal. $14. 1.25" eyepiece-projection adaptor. $35. T-ring for Nikon. $6. 2" prime-focus adaptor. $19. Two 5" f/3.5 coated anastigmatic Tridar projection lenses. $25 each. Three 146mm right-angle prisms. $15 each. 44mm f/1 24x169mm cylinder lens. $8. Shipping extra. Contact John Ramser, 3016 Belmont Drive, Roswell, NM 88201. Phone (505) 624-1784.

ASTRONOMY DESIGNS
on heavyweight, T-Shirts, long-sleeve t-shirts & sweats
CALL OR WRITE FOR OUR FREE CATALOG
Caledonian Graphics,
Dept. A,
P.O. Box 875, Zephyrhills, Fl. 34283.
1-800-223-4607
CALEDONIAN GRAPHICS

Scope City
Largest, Most Complete Optical Supermarket in the World



Scope City

MAIN OFFICE
679 Easy St.
Simi Valley,
CA, 93065
(805) 522-6646

MAIL ORDER
P.O. Box 440
Simi Valley, CA 93065
Info & ordering in CA
(805) 522-6701
Nat'l (800) 235-3344
Send for a FREE discount price list. $5.00 for catalog package.

WE SHIP TO THE WORLD

SAN DIEGO, CA
4766 Clairemont Mesa Blvd.
(805 Fwy. to Clairemont Mesa Blvd., exit west)
(619) 277-6686

COSTA MESA, CA
3033 S. Bristol
(405 Fwy. to Bristol exit, 2 blks. south)
(714) 957-6900

TORRANCE, CA
3132 Pacific Coast Hwy. (405 Fwy. to Crenshaw exit south, west on Pac. Coast Hwy. 3 blks.)
(213) 326-3251

SIMI VALLEY, CA
679 Easy St.
(118 Fwy. to First St. exit, south ½ mile, right on Easy St. 2 blks.)
(805) 522-6646

LAS VEGAS, NV
2216 Paradise Rd.
(Corner of Paradise Rd. and Sahara Ave., across from Sahara hotel.)
(702) 733-9288

SURPLUS STORE
679 Easy St.
Simi Valley, CA 93065
(118 Fwy. to First St. exit, south ½ mile, right on Easy St. 2 blks.)
(805) 522-6646

EMPLOYMENT OPPORTUNITIES AVAILABLE. WRITE MAIN OFFICE.

more images. The discussions by the scientists were helpful but could have easily been done as voice-over commentary while more images were shown.

After the main attraction the video shows two versions of "Miranda: The Movie." This is a simulated flight at low altitude (about 20 miles) across parts of Miranda's southern hemisphere.

The two versions show exactly the same sequence, but the first runs about twice as fast as the second and has almost no commentary but an appropriately spacey musical soundtrack. The second version provides a much more detailed commentary that explains what features you are seeing and says something about the surmised geology.

I hadn't seen the clip before, so the final few seconds with the kamikaze flight *blam!* straight into a mountainside were a delightful surprise. — *Robert Burnham*

CCD CAMERA

EDC-1000 CCD camera, (Electrim Corp., P.O. Box 2074, Princeton, NJ 08543), $400.

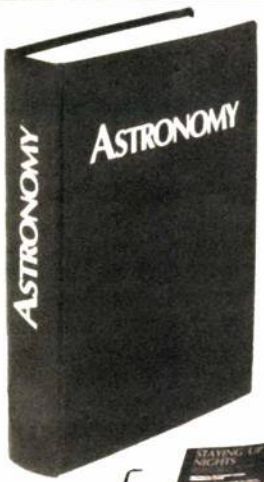
The CCD chip in this camera measures 192 by 165 pixels and can be scanned with exposures from 50 milliseconds to 2 seconds. Any IBM PC, XT, AT, PS/2 model 25 or 30, or compatible, with PC-DOS or MS-DOC versions 2.1 or higher, can control it. The computer communicates with the camera from up to 20 feet away, sending power, timing, and video signals through a single cable. The software supplied will support CGA, EGA, MCGA, VGA, and Hercules adaptors and can save images in Tag Image File Format or PC Paintbrush format.

The housing measures 2¼-inch by 2¼-inch by 1½-inch, weighs less than half a pound, and the lens, which comes on a C mount, can be removed. Price includes camera, 6-foot cable, 16mm f/1.6 lens, computer interface card, software, and manual.

Note: The *Voyager* software reviewed in the March 1989 issue is produced by Carina Software, 830 Williams Street, San Leandro, CA 94577; (415) 352-7328. □

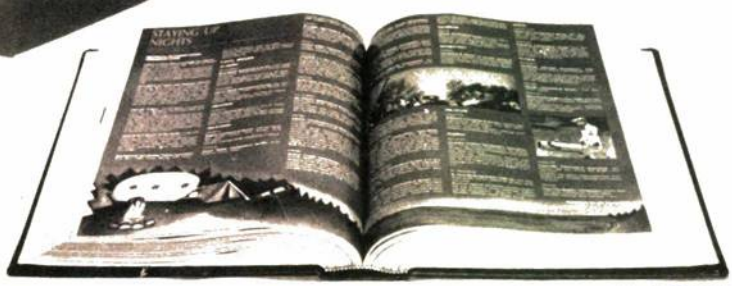
MEADE LX6
TOP-OF-THE-LINE
FAST • FULLY-EQUIPPED • BEST VALUE
Meade THE LEADER'S EDGE
• Wide-Field f/6.3 Optical System
• All-New Ultra High Contrast Light Baffling
• Built-In Digital Readout Capability
• 59% wider field of view than F/10
• 2 1/2X brighter images than F/10
• 60% reduction in astrophoto exposer times.
CALL FOR PRICE!!
Authorized Meade dealer
THIS MONTH SPECIAL
MEADE DEEP-SPACE
16" Wide Field Telescope
DS16A ONLY $1679
MEADE SERIES 4000
Quality Eyepieces
Call for best price! Start from $69
Call Now !!! 714-530-3861
FAST DELIVERY
NEW FROM CELESTRON
8" Schmidt-Cassegrain Telescope
• Same optical quality as the Ultima 8
• Spur gear drive system
• 25mm Ocular 1 1/4" (81x)
• 6x30 Straight Finderscope (8.0 field.)
• Star diagonal 1 1/4"
• Wedge • Much More
CLASSIC 8
ONLY $899
Accessories
• Any Meade CAT .. $1185
• Any Meade DSC $374
• Digital Readout for LX6 $335
• Any Meade CAT-COM . $1295
Call for other Access. Meade or Celestron
TeleVue Eyepieces
PLOSSLS
7.4, 10.5, 13, 17, 21, 26 mm $69
32, 40mm $89
55mm/2" $149
WIDE FIELD
15mm $119
19mm 4129
24mm $139
32mm/2" . $189
40mm/2" $249
NAGLER
4.8mm $129
7mm $159
9mm $189
11mm $199
13mm $209
12mm II $209
16mm II $239
20mm II $299
3%
CENTURY TELESCOPE (1 MILE SOUTH OF DISNEYLAND)
12555 HARBOR BL. GARDEN GROVE, CA 92640

NOW AVAILABLE!



ASTRONOMY BOUND VOLUME NO. 16
1988

Here it is – a complete year of exciting feature articles, colorful star charts, useful tips on using telescopes, and how to take beautiful astrophotographs. ASTRONOMY Bound Volume No. 16 includes the January 1988-December 1988 issues, plus a useful index, all protected between hard covers. Supplies are limited – order your copy today! $33.95 ($43.95 outside the U. S.) #44016



To order, use the ASTRONOMY order form bound in this magazine, or send to ASTRONOMY Order Dept., 1027 N. 7th St., Milwaukee, WI 53233. Include for postage and handling: U. S. $1.50; Canada and foreign add 15%. Wisconsin residents add 5% sales tax.

Readings and Resources

Space Station (page 24)

The Space Station by Hans Mark, (Duke University Press, 1987). An insider's view by a former NASA deputy administrator of how the Space Station made its way through the NASA hierarchy from the *Apollo* era to President Reagan's decision to start the project in 1984.

Rings around Neptune (page 36)

Planetary Rings, edited by Richard Greenberg and Andre Brahic, (University of Arizona Press, 1984). A broad reference on all matters pertaining to rings. Superb coverage of the Saturnian and Jovian ring systems.

Rings by James Elliot and Richard Kerr, (Massachusetts Institute of Technology Press, 1984). An excellent popular-level account of the discovery of the Uranian rings written only a few years ago when Neptune "didn't have" rings, the text explains why rings had been ruled out by top investigators.

"Towards a Theory for Neptune's Ring Arcs" by Peter Goldreich, *et al.*, *Astronomical Journal*, August 1986. The most relevant paper on Neptune's rings.

Elliptical Galaxies (page 42)

"Colliding and Merging Galaxies" by Francois Schweizer, *Science*, January 17, 1986. A highly readable article about how observations and advances in computer technology are helping astronomers understand the role of mergers in galaxy formation and evolution.

"Violent Tides between Galaxies" by Alar and Juri Toomre, *Scientific American*, December 1973. A popular article still worth reading that describes how simple gravitational models reproduce "bridges" and "tails" in observed galaxies.

Pluto at Its Best (page 84)

"Circumstances for Pluto-Charon Mutual Events in 1989" by David J. Tholen and Marc W. Buie, *Astronomical Journal*, December 1988. Includes details of all the mutual events occurring in 1989.

"Pluto Emerges from the Shadows" by David J. Eicher, ASTRONOMY, September 1988. That latest on what astronomers have learned about Pluto from the Pluto-Charon mutual events.

CREDITS

Cover: Tony Hallas and Daphne Mount (5-inch f/8 Starfire with field flattener, Konica 400 hypered 120 film, 90-minute exposure); *page 4*: Sterne Photography; *page 10*: illustration by G. Dana Berry, Space Telescope Science Institute Astronomy Visualization Lab; *page 12*: European Southern Observatory; *page 18*: illustration courtesy of Martin Marietta Corporation; *page 20*: Richard Berry; *pages 24-25*: NASA illustration by Vincent Di Fate; *page 26, top*: Martin Marietta Corporation, *middle*: Government of Canada; *pages 27, 28, and 30*: NASA; *page 29, middle*: McDonnell Douglas Astronautics Company; *pages 36-37*: painting by Michael Carroll; *pages 38 and 40*: diagrams courtesy of Ellis Miner, Jet Propulsion Laboratory; *page 43*: Francois Schweizer, Carnegie Institution of Washington; *page 44-45*: computer series by Joshua Barnes, Institute for Advanced Study, *page 44, middle*: Francois Schweizer, Carnegie Institution, and Patrick Seitzer, National Optical Astronomy Observatories, *bottom*: ESO 415-G26, Space Telescope Science Institute; *page 51*: Davis Planetarium, Maryland Science Center, Maryland Academy of Sciences; *page 52*: McDonald Observatory; *page 53*: Adler Planetarium; *page 54*: National Optical Astronomy Observatories; *page 55*: Kelly Planetarium, Discovery Place/Nature Museum of Charlotte; *page 57*: Roper Mountain Science Center; *page 64*: Mace Hooley (composite image of two 30-minute exposures, 15mm fisheye lens, Fuji 400 film); *page 66*: sketch by Richard Baum, March 15, 1952; *page 67*: base map from *Uranometria 2000.0*, volume 2, © Willmann-Bell, Inc., 1988; *page 72*: John Sanford; *page 73*: David J. Eicher; *page 74*: Dayton Museum of Natural History; *page 75*: Lynn Atkins; *page 77*: Perseid photo by David D. Gagnon, lunar eclipse photo by Clay Ruth; *page 78*: A. L. Schmidt; *page 84*: binocular view base art from *Uranometria 2000.0*, © Willmann-Bell, Inc., 1987; *page 88*: table of mutual events compiled with data from David J. Tholen and Marc W. Buie, *Astronomical Journal*, volume 96, page 1977; *page 90*: Lee C. Coombs (10-inch f.5 reflector, 103a-O film, 10-minute exposure); *page 91, top*: Jack Newton (20-inch f/5 reflector), *bottom*: David J. Eicher, (17.5-inch reflector at 71x); *page 92, top*: Scott Hicks (12.5-inch f/4.8 reflector, Konica 400 film, 15-minute exposure), *middle*: Martin C. Germano (8-inch f/10 SCT, 103a-F film, 50-minute exposure), *bottom*: Jack Newton, (16-inch f/5 reflector, 15-minute exposure); *page 93*: Jack Newton (12.5-inch f/4.6 reflector, 103a-F film, 10-minute exposure); *page 94, top*: Jack Newton (16-inch f/5 reflector, 16-minute exposure), *bottom*: Martin C. Germano (8-inch f/5 reflector, 103a-F film, 20-minute exposure); *page 95*: Bill Iburg (14-inch f/9 SCT, chilled Ektachrome 400 film, 20-minute exposure at top, 14-inch f/5.5 SCT, chilled Ektachrome 400 film, 25-minute exposure at bottom); *page 98, top*: data compiled by Gregg D. Thompson, sketch by David J. Eicher, *bottom*: Kim Zussman (11-inch f/10 SCT, hypered Tech Pan film, 40-minute exposure); *page 99*: Ronald E. Royer (18-inch f/7 reflector, 103a-O film, 40-minute exposure); *page 101, left*: Peter O. Taylor, *right*: sketch by Mario Rene Ortiz Davilla (2.4-inch f/15 reflector at 227x); *page 104*: by Greg Kot.

ADORAMA
The Photography People
42 W. 18th St., New York, N.Y. 10011

CELESTRON
SCHMIDT CASSEGRAIN TELESCOPES

New Powerstar 4 — INCLUDES: STARBRIGHT COATING, BUILT-IN DRIVE CORRECTOR, DC OPERATION, WEDGE, 30mm PLOSSL, 7mm ORTHO, AC ADAPTER, T ADAPTER, PIGGY BK MOUNT, DEWSTAR, PRODUCT GUIDE ..... Call
Powerstar 3 ..... 1489.95

ACCESSORIES FOR POWERSTAR
Dec. Motor ..... 87.95 Focus Motor 94.95
Car Battery Adapt 14.95

NEW ULTIMA & CLASSIC 8
New Ultima 8 ..... Call
New Hand Controller for Ultma 109.95
NEW CLASSIC 8 ..... Call
Dec Motor f/Ultima & Classic 109.95
Focus Motor f/Ultima & Classic 129.95
Adjustable Motor f/Classic 8 ..... 199.95

COMPUSTAR TELESCOPES
Compustar C8 ..... 3299.95
Heavy Duty Wedge 229.95
Compustar C11 ..... 6699.95
Compustar C14 ..... Call
AC Supply 379.95
Joystick 99.95

SUPER POLARIS C8
Super Polaris C8 ..... Call
Super Polaris C8 w/Starbright Coating ..... Call
SUPER POLARIS ACCS
Single Axis Drive 154.95
Dual Axis Drive 244.95
Car Battery Adapt 16.95
AC Adapt 19.95

NEW DIGITAL SETTING CIRCLES
DSC For All C8 (except Ultima)
Only 399.95
DSC FOR NEW ULTIMA
Only 399.95
NEW ASTRO MASTER
A DSC for all Super Polaris Mount Telescopes
459.95

NEW STEREO BINOCULAR
For relaxed two eye viewing
499.95

REFLECTOR TELESCOPES
NEW C4.5" Newtonian 439.95
Motor Drive f/C4.5 C6 Comet Catcher 169.95
Polar Axis Finder w/Illum f/C6, CC, C4.5 ..... 48.95
Tele Extender Refractor/Newtonian 44.95

REFRACTOR TELESCOPES
Super Polaris C102 102mm 999.95
Super Polaris C102 Fluorite 2099.95
New Firstscope 80 w 45° Erect Prism 469.95
T Adapter Refractor/C4.5 ..... 32.95
New 60mm Altazimuth 154.95
New 60mm Equatorial 279.95
Correct Image Eyepiece f/60mm Ref 19.95
T Adapt/Tele Extender f/60mm REf 43.95
New Solar Screen Filters ..... Call

SPOTTING SCOPES
The New C90 Includes: 8x20 Erect Image Finder, 45° Erect Image Diagonal, 30mm .96 E.P., Foam Fitted Case
NEW C90 Basic 354.95
NEW C90 Basic w Multi Coating 389.95
NEW C90 Rubber 409.95
NEW C90 Rubber w Multi Coating 449.95
1¼" Super C90 Upgrade Kit 104.95
NEW C65 Rubber Coat 206.95
NEW Zoom Master II 299.95
NEW SS-80 ..... 329.95

CELESTRON C90 ACCS.
Cometron 2x Barlow .96 ..... 19.95
Barlow .96 2.2.5.3X ..... Ea. 31.95
4.5.6.7.9.12 Ortho .96 ..... 39.95
10.18.25.30.40 Kinr .96 ..... 34.95
Zoom Ocular .96 ..... 69.95
LAR C90 ..... 22.95
Mult Ocular .96 Hold 69.95
Porro Prism .96 ..... 41.95
Diag Prism 45 .96 ..... 49.95
Diag Prism 45 .96 to 1 ..... 49.95
Series 5 Filter Set 49.95
Skylight Filter #1 ..... 34.95
Deluxe Slow Motion Ctl 44.95
T Adapt. C90 ..... 29.95
Photo Tripod 109.95

CELESTRON TELESCOPE ACCS.
New Improved Accs Cs 44.95
New Fitted Cs f C8 ..... 119.95
Barlow 1¼" 2x 39.95
Barlow 2" 2x 79.95
Barlow Lens 3X 34.95
Deluxe Barlow 1¼" 2x 76.95
Counterwt Bar Assm 8" 94.95
Counterweight Set 8" 49.95
Drive (SA) C8 ..... 129.95
45° Erect Prism 49.95
New 90° Diagonal Prism 79.95
Dewstar Shade 8" 19.95
8x50 RA Pol Find C8 ..... 124.95
Focus Motor 11 14 ..... 119.95
Illum Reticle EP 94.95
Illum Proj Reticle 1¼" 144.95
Image Corrector 1¼" 19.95
LPR Filter #2 f 2" E.P. 99.95
LPR Filter #3 f .96 E.P. 49.95
Eyepiece Filter Set 2" 64.95
Mult Ocular Hldr 1¼" 119.95
Off Axis Guiding Sys 144.95
Photo Tripod Adapt 8" 43.95
Piggyback Mt 8 11 14 ..... 34.95
Polarizer Filter Assm 109.95
Polarizer Set 1¼" 49.95
Porro Prism 1¼" 49.95
Rich Field Lens f 1¼" EP 24.95
Rich Field Adapt w Plossl 99.95
Series 6 Filter Set 54.95
New Star Diag 1¼ MC 47.95
Solar Filter 8" 279.95
Solar Filter Off Axis f 8" 149.95
Super Polaris 8" Mount 549.95
Sky Filter #2 ..... 37.95
2" Wdstr Diag w 1¼ MC 114.95
Adj. Tripod 199.95
Tripod Accs Tray 59.95
Tele Extender 29.95
Tele Compressor 57.95
Casters f Adj Tripod 39.95
Wedge f C8 ..... 74.95

NEW CELESTRON 1¼ EYEPIECE FILTERS
Available in the following colors:
1A Skylight: 8 Yellow: 12 Deep Yellow: 15 Deep Yellow: 21 Orange: 23A Red: 25 Red: 38A Blue: 47 Violet: 56 Light Green: 58 Green: 80A Light Blue: 82A Pale Blue: ND 0.3: ND 0.6: ND 0.9:
Each 13.95
Buy any 4 filters for only 49.95
New Polarizing Filter 1¼ 16.95

CELESTRON EYEPIECES
50mm Plossl 2" 129.95
32mm Erfle 2" 129.95
40mm Ortho 2" 129.95
24mm 1¼" Erfle 52.95
32mm 1¼" Erfle 56.95
4.5.6.7.9.12.18.25mm 1¼ Ortho 49.95
7.5.10.17.22.26.30.36.45mm 1¼ Plossl 67.95
Zoom Ocular (8.4-21mm) 1¼" Ortho 99.95

MAIL ORDER DEPT. MON.-THURS. 8-9:30, FRI. 8-1:45, SUN. 9:30-6 PM EST

©1989

ADORAMA

42 W. 18th St., New York, N.Y. 10011

ORDERS & INFO (212) 741-0052

FAX: (212) 463-7223

STORE HOURS MON.-THURS. 8:00-5:45 FRI. 8-1:45, SUN. 9:30-5:45

FOR ORDERS ONLY: TOLL FREE OUT OF STATE 800-223-2500

HAWAII & ALASKA: 800-232-7662

Customer Relations: (212) 741-0466 (Mon.-Thur. 9-4:30 pm EST Fri. 9-1)

COMPLETE W/MANUFACTURER'S ACCESSORIES

Meade

SCHMIDT-CASSEGRAIN

NEW LX6 MC/OG

2080 LX6 Complete 1789.95
2120 LX6 Complete 2359.95
Digital Readout System f/LX6 ..... 319.95
Jims Mobile Moto Focus 79.95

LX5 MC/OG

2080 LX5 Complete 1499.95
2120 LX5 w/MCOG
Complete w/Wedge & Tripod 1799.95

LX5 ACCESSORIES

#39 Dec Motor 92.95
#39 w/9.7 Super Plossl (AP6) 153.95
1200A Elec Focuser 169.95
Jim's Mobile Moto Focus 79.95

LX3 w/MCSO

2080 LX3 MCOG Complete 1249.95
2120 LX3 MCOG Complete w/#36 Cont. Box 1669.95

LX TELESCOPE ACCS.

#36 Ctl Box ..... 84. #38 Dec Motor ..... 80.
#36 w/#38 Dec (AP4) 149.95
#38 w/9.7 Super Plossl (AP5) 142.95
1200 Elec Focuser 149.95
Jim Mobile Moto Focus 79.95

NEW BASIC 2080

A new low price 8" Schmidt-Cassegrain Telescope ..... Call

NEW CAT / DSC

(COMPUTER AIDED TELESCOPE SYSTEM · DIGITAL SETTING CIRCLE)

CAT f all 2080 Meade 899.95
CAT f all 2120 Meade 829.95
CAT f new Meade LX6 ..... Call
CAT f Celestron C8, C11 ..... Call
CAT f German Mounts ..... Call
DSC f 2080 Meade ..... Call
DSC f 2120 Meade ..... Call
DSC f Celestron C8 11 ..... Call

MEADE EYEPIECES

SERIES 4000

Super Plossl		Ultra Wide		Super Wide	
6.4,9.7,12.4,15, 20,26	65.95	4.7mm	119.95	13.8mm	109.95
32, 40mm	85.95	6.7mm	153.95	18mm	119.95
56mm (2")	153.95	8.8mm(1¼,2")	174.95	24.5mm	133.95
Barlow 2X	62.95	14mm(1¼,2")	199.95	32mm (2")	179.95
				40mm (2")	244.95

MEADE TELESCOPE ACCS.

Accs. Case #50 ..... 69.95
Accs Shelf 29.95
2X Barlow 1¼ #122 ..... 44.95
Variable 2X,3X 1¼ #127 ..... 59.95
Rotary EP Holder 1¼" 113.95
45° Erect Img #928 E.P. 49.95
Wide Field Adapt Sys 109.95
2" Star Diag w/Adapt f/1¼ E.P. 139.95
Off Axis Guider Assm 139.95
Illum Reticle E.P. 1¼" 79.95
Photo Visual Filt Set 6 pc. 79.95
#910 Nebular Filter 2" 106.95
#1A Sky Filter 44.95
#908 Nebular Filter 1¼" 62.95
#911 Nebular Filter 116.95
Dew Shield (2080) 56.95
Dew Shield (2120) 94.95
Piggy Bk Brkt 2080/2120 ..... 32.95
Tube 1401 ..... 84.95
Tube 1402 ..... 89.95
Tele Extender 29.95
Tele Compressor Sys 65.95
8x50 Pol Illum Find 129.95
9x60 Polar Illuminated Finder w/Bracket 154.95
#43 R.A. Drive 79.95
LED Map Light 27.95

MTS TELESCOPES

MTS-SN6 w/cs 529.95
MTS-SN6 MCOG 579.95
MTS-SC10 ..... 1239.
MTS-SC10 MCOG ..... 1339.
MTS-SC8 8" w/LX3 Drive & Setting Circle 1089.95
MTS-SC8 8" w/Drive & Setting Circles 919.95
MTS-SN6 6" w/Drive & Setting Circle 619.95
MTS-SN8 8" w/LX3 Drive & Setting Circle 899.95
MTS-SN8 8" w/Drive & Setting Circle 759.95

MTS ACCESSORIES

#788 Drive 119.95
#790 LX3 Drive 349.95
#66A Manual Dec Control f/SN6, SN8 ..... 44.95
#66C Manual Dec Control f/SN8, SC10 ..... 56.95
#38M Electronic Dec System 86.95
#36 w/#38M & 66C (AP7) 179.95
#36 w/#38M & 66A (AP1) 169.95
#43 Drive Corrector & AC/DC Converter 79.95
6x30 Viewfinder w/Bracket f/SN6, w/#140 Barlow (AP2) 94.95
8x50 Viewfinder w/Bracket f/SN8 w/#140 Barlow (AP3) 122.95
8x50 Polar Illum Viewfinder w/Bracket f/SC8, SC10 ..... 129.95

REFRACTING TELESCOPES

226 60mm Altazimuth 149.95
291 60mm Equatorial 299.95
312 80mm Altazimuth 434.95
323 80mm Equatorial 479.95
314 80mm Brass 899.95

ACCS f/MEADE REFLECTORS/REFRACTORS

Basic Camera Adapter 1¼" 39.95
Variable Projection Camera Adapter 1¼" 59.95

SPOTTING SCOPES

New Pathfinder II 15-60x Zm 199.95
97E 3.5" Compl 359.95
97ER 389.95
97D 319.95

DEEP SPACE TELESCOPES & REFLECTORS

DS-10A 819.95
DS-16A 1689.95
826C 899.95
1060 ..... 1999.95
1266 ..... 2899.95

BAUSCH & LOMB

ASTRONOMICAL TELESCOPES

BAUSCH & LOMB DISCOVERER

78-1600 15-60x Spotting Scope 179.95
78-9107 Discoverer Case 44.95
22-3030 Camera Adapt ..... 19.95 Car Window Mount 36.95

SPACEMASTER (60mm)

78 1800 Standard 139.95
78-1200 NEW Rubber Armored 149.95
78-1817 Spacemaster Kit w 15-45x, tripod, shoulder case 229.95

NEW! SPACEMASTER II (70mm APO)

78-1900 Spacemaster II 143.95
78-2200 NEW Rubber Armored Waterproof 15x45X Zoom Spacemaster 299.95
78-1917 Spacemaster II Kit w Zm EP, tripod, shldr cs 234.95

ACC. FOR SPACEMASTER 60mm/70mm

15,20,25,60X Eye Pieces ..... @ 36.95
22X W.A. 41.95
f 60mm 29.95
15-45X Zoom 84.95
f 70mm 37.95
Camera Mount 60mm 29.95
70mm 39.95

SUPER-CASSEGRAIN

800mm f/10 Spotting Scope - only 8" long and weighs 1 oz. Comes w/2 1¼" Plossl E.P. (18 & 30) Star Diag and T Adapt 219.95

ASTRONOMICAL ACCESSORIES

LIMITED AVAILABILITY

4.6mm Orthoscopic 1¼ 29.95
#631049 Camera Mount f/4000 ..... 34.95

Tele Vue®

"Tops in the Field"

PLOSSL

New 55mm 2" w/Eyeguard 179.95
55mm 2" 154.95
40,32mm 1¼" 79.95
26,21,17,13, 10,5,7,4mm 1¼" 67.95

WIDEFIELD

40mm 2" 236.95
32mm 2" 181.95
24mm 1¼" 126.95
19mm 1¼" 115.95
15mm 1¼" 111.95

NAGLER

20mm Type 2; 2" 284.95
16mm Type 2; 2.1¼" 233.95
13mm 2.1¼" 195.95
12mm Type 2; 2.1¼" 204.95
11mm 2.1¼" 185.95
9mm 2.1¼" 189.95
7mm 152.95
4.8mm 121.95

BARLOW

2.5X, 1.8X 1¼" ..... ea. 69.95

ACCESSORIES

2" Star Diagonal 139.95
Rich Field Kit (55 Plossl, 2" Star Diag., Adapter, Reducer) 289.95
Rich Field Kit w New 55 Plossl 319.95
1¼ E.P. Adapter f/Questar 59.95

TELEVUE REFRACTOR

NEW! Genesis 4" (101mm) f/5 Fluorite APO
The Ultimate Refractor ..... Call
Oracle 3" (7mm) f/7.4 -
The Quality Refractor at an Economy Price 629.95
Renaissance 4" (101mm) f/5.5 Brass Refractor ..... Call

MOUNTS FOR TELEVUE REFRACTORS

TV Panoramic Brass & Wood Alt-Azimuth Mount 349.95
Celestron Super Polaris Equatorial Mount w/TV Adptr Plate 599.95
Televue Equatorial System Mount w/Wood Tripod, Adpt. 819.95
Televue Equatorial Mount w/Alum. Tripod & Adpt 779.95

Edmund Scientific

Astroscan 2001 ..... 259.95

Edmund Scientific's affordable wide-field, go-anywhere telescope gives super bright images

RKE Eyepieces 1¼" 33.95
Orthoscope E.P. 1¼" 42.95
8x4-21 Zoom Ortho 86.95
2.5 Rke Barlow 59.95
Variable Barlow 25.95
Straight-Thru Image Erctr 49.95
R.A. Prism Erector 32.95
Variable Cam. Adapt 48.95
Tripod Bracket 37.95
Carry Bag 27.95
Sun Screen 34.95

3" F/6 f/6 Reflector 179.95

ADORAMA EYEPIECES & ACCS

Portable Rechrg DC Pk 69.95
1¼ Orth 6,9,12,5,18,25 ..... 39.95
1¼ Star Diag 31.95
1¼ Barlow 2x,3x ..... @ 31.95
Rubber Eye Grd f/96 ..... 5.95
Rubber Eye Grd f/1¼" EP 6.50
Rubber Eye Grd f/2" EP 6.95
1¼"-2" Adapt 34.95
2" to 1¼ Adapt 24.95
1¼ to 96 EP Adapt Sys 19.95
96 to 1¼ EP Adapt Sys 17.95
96 Barlow 2x ..... @ 24.95

WE HAVE NO SURCHARGE ON ON CREDITCARD ORDERS (MC/VISA)

TELESCOPE ACCESSORIES

LUMICON

UHC PREMIUM FILTERS

1¼" 99.50
48mm f/most 2" EP 199.95

DEEP SKY PREMIUM FILTERS

.96" 59.50
1¼" 79.50
2" 99.50
48mm 119.50

H-BETA

1¼ 99.50
48mm 199.50

OXYGEN III

1¼ 99.50
48mm 199.50

New Lumicon Sky Vector (DSC) f/Meade & Celestron Schmidt Cassegrains 498.95

SOLAR FILTER

By Thousand Oaks Optical

GLASS TYPE 2 MOUNTED

3.1" 61.95
4" 71.95
5" 92.95
6" 99.95
8" 119.95
10" 129.95
11" 149.95
12.5" 169.95
14" 199.95

DRIVE CORRECTORS

DIGITRAK I

VE400 ..... 159.95
VE400D 199.95

NEW DIGITRAK II

VE400 ..... 194.95
VE400D 249.95

Telrad

Finder w/Mounting Base 39.95

TELESCOPE PARTS

IDAI 4.5" f/7.8 (860mm focal len) w/Matching Elliptical Flats 59.95
IDAI 5" f/8 (980mm focal len) w/Matching Elliptical Flats 89.95

MEADE PARABOLIC MIRRORS

6" f/8 ..... 129.95
8" f/6 ..... 189.95
10" f/4.5 ..... 409.95
6" f/5 ..... 139.95
10" f/6 ..... 409.95
12.5" f/6 ..... 599.95

MEADE ELLIPTICAL FLAT SECONDARY MIRRORS

1.3" 29.95
1.83" 38.95
2.6" 49.95
1.52" 37.95
2.14" 42.95
3.1" 82.95
4" ..... 120.

MEADE MIRROR CELLS

6" 49.95
10" 99.95
8" 57.95
12.5" 119.95

MEADE RACK & PINION FOCUSER

#67 1¼" ..... 49.
#640 1¼" ..... 89.
#680 1¼" ..... 109.

CAMERA FOCUSING SCREENS & ACCS

NIKON

Matte (B2) f/FE2, FA 19.95
Matte (D) f/F3 ..... 24.95
Matte (D) f/F2 ..... 29.95
DR-3 Right Angle Finder 94.95

CANON

All Matte (C) f/EOS (EC) 19.95
f/F1-N 64.95
f/T90 ..... 18.95
Angle Finder B 78.95

BEATTIE INTERSCREENS

4x BRIGHTER

Nikon F2 ..... 89.95
Nikon F3 ..... 89.95
Nikon FE2, FM2, FA 54.95
Pentax LX 54.95

OLYMPUS

All Matte (1-8) 21.95
Varimani Finder 79.95
Olympus OM1,2,3,4 ..... 54.95
F/Other Models ..... Call f/Prices

PUBLICATIONS

Sky Atlas 2000.0 Color 34.95
Uranometria 2000.0 Vol 1 or 2 ..... 37.95
The Cambridge Atlas of Astronomy 90.00
Sky Catalog 2000.0 Vol 1 or 2 ..... 29.95
Nortons Sky Atlas 29.95
Edmnd Mag 6 StarAtlas 16.95
Celestron Sky Maps 15.95
Passport To The Stars 49.95
Exploring The Sky w/Binoculars 3.95
The Night Sky 2.95

ASTRO FILM

KONICA

3200 ASA 135-24 ..... 4.69
3200 ASA 135-36 ..... 5.69
1600 ASA 135-24 ..... 3.59
1600 ASA 135-36 ..... 4.69

3M

640T 135-36 ..... 6.79
1000 135-36 ..... 6.99

KODAK

TP (Tech Pan) 135-36 ..... 3.90
TMZ (3200) 135-36 ..... 4.19

BINOCULARS

SWIFT GIANT

Observer 11x80 BCF 249.95
Satellite 20x80 BWCF 259.95

SPOTTING SCOPES

Telemaster 15-60x60 ..... 214.95
Searcher 20x40x60(12°) 219.95
Lynx 20-60x65 ..... 409.95

STEINER

15x80 G Observer 619.95
15x80 C Obs w/Cmp 779.95
24x80 Telescope 459.95

ZEISS W/O CASE

8x56 CF GA 809.95
15x60 CFT*GA 1239.95
30x60 BGAT* 949.95
Motor Foc f/30x60 ..... 159.95

SWAROWSKI

8x56 SL ..... Call
10x50 SL ..... Call

ARMORED SPOTTING SCOPES

T30x75 G ..... Call
T30x75S NZG ClsFoc ..... Call
T30x75 NZG Cls Foc Short Tube ..... Call
T 25-40x75 SNZG Short Zoom Close Foc ..... Call

FUJINON

7x50 Fmt-SX 439.95
10x70 Fmt-SX 549.95
15x80 MT w Mount 2399.95
25x150 RA w Mount, Trpd 9299.95

CELESTRON GIANT

NEW MULTI-COATED

11x80 MC 299.95
20x80 MC 309.95
Deluxe 14x80 MC 449.95
20x80 Deluxe MC 469.95
NEW 14x100 MC 999.95
NEW 20x100 MC 999.95
Car Window Mount 69.95
7x50 WA Nova 199.95
10x50 Nova 189.95
7x42 8x32 Ultima 199.95

MEADE GIANT

11x80 Rubber 249.95
20x80 ..... 259.95
30x80 ..... 289.95

NIKON

7x50 CF Star Vue 153.95
10x50 CF Sentinel 166.95
7x50 SPHP w/cs 529.95
10x70 HP w/case 499.95

SPOTTING SCOPES W/CASE & 20X EYEPIECE

Spotting Scope 319.95
Spotting Scope ED 514.95
Photo Attachment 119.95
72mm Filter Ring 14.95
Hood 11.95
15,20,30,40, 60x E.P. ..... Ea 49.95
Lens Scope Converter 49.95

BINOCULAR ACCS

Car Wdw Mt (SWCWM) 34.95
Celestial Innovations Binocular System f/Giant Binoculars 109.95

WE SHIP PROMPTLY

No Surcharge for MasterCharge or Visa purchases. Personal checks welcome, will ship without delay. Name must be imprinted on check, also include address, phone, and a copy of major credit card or drivers license for reference. Shipping, handling and insurance additional. 14 day money back guarantee less shipping, with packing and blank warranty card, except film and paper. We ship UPS. Some items special order. All orders are subject to acceptance and verification. Second hand dealers license #802862. Pictures are for illustration purposes only and may not be exact. **Prices effective till May 3, 89** **Please address all inquires and orders to ASTRO DEPT #55**

ASTRONOMY Advertisers

May 1989

A.M. Plastics 110
Ad-Libs Astronomics 87
Adorama Camera 116-117
Andromeda Software Inc. 110
ARC Software 114
Astro-Tech 110
Astronomy Book Club 11
ASTRONOMY Products .. 21,46,96,101,102-103 108,109,110,111,115

Berger Brothers Camera Exchange 96
Bethany Trading Co. 100

Caledonian Graphics 114
California Telescope Co. 22-23
Cambridge University Press 99
Celestial Innovations 112
Celestron International 16-17,120
Century Telescope Center 115
Cosmic Connections, Inc. 100
Coulter Optical Co. 104

Denny's Astro Mart 100

Easton Press 9

Focus Camera, Inc. 88
Franklin Mint, The 15
Fujinon, Inc. 19

Galleria 107

Harvard Camera Centers 114
Harvard University Press 105
Hayden Planetarium 114
Hayes & Nolly Productions, Inc. 110

Kinard Manufacturing Co. 19
Khan Scope Centre 110
Krauth Co., The 96

Lumicon 48-49

Meade Instruments Corp. 2-3,32-33
Meteorites 114
Miko 111

National Camera Exchange 97
New England Astro-Optics, Inc. 96
Northern Sky Telescopes 13,110

Orion Telescope Center 58-59

Parks Optical 41
Pauli's Optical Supply 100,114
Plenum Publishing Corp. 100

Quasar Optics, Inc. 100

Roots Research Bureau, Ltd. 34-35

Scope City 114
Shutan Camera & Video 113
Star Hill Inn 110

Tele Vue Optics, Inc. 7,119
Tuthill, Roger W., Inc. 47

U.S.A. Sport Optics 89

Vernonscope & Co. 112
Vista Instrument Co. 96

Wellock Instructional Needs 100
Wholesale Optics of PA 100

Zephyr Services 106

Reader Exchange notices are free to all our readers for non-commercial purposes — but only two per person, per year, please. Limit your notice to 40 words including your name and address and allow 4 to 6 months for it to appear. All notices are subject to review for suitability. Kalmbach Publishing Co. assumes no responsibility for statements made in notices or for the quality of items offered. Send notices to: Astronomy Magazine, Editorial Dept. RE, 1027 N. Seventh St., Milwaukee, WI 53233.

COMING IN THE JUNE 1989 ISSUE OF ASTRONOMY

Earth's Violent Birth Astronomers are taking a new look at the origin and evolution of Earth and the Moon.

The* Space Telescope *at Work Observing with the *Hubble Space Telescope* is a complex task of scheduling, pointing, and observing.

Build Yourself an Observatory This easy-to-build observatory will make observing an easier and warmer experience.

AVAILABLE ON YOUR NEWSSTAND MAY 16

READER EXCHANGE

WANTED – Any literature (sales, accessories, magazine articles, etc.) on Consolidated Systems 7" to 7-1/2" f/10 Maksutov telescopes manufactured approximately twelve to fifteen years ago. Contact Bill Kohler, 146 North 9th, Philomath, OR 97370.

WANTED – Fifteen-year-old female seeks correspondence with other U.S. teens (male or female) interested in astronomy. Contact Katherine Hare, 60 Broad View Road, East Providence, RI 02914.

WANTED – Fifteen-year-old female seeks correspondence with other teens around the world interested in astronomy, life on other planets, and science fiction. Contact Erin McAllister, 605 221st SW, Bothell, WA 98021.

WANTED – Sixteen-year-old seeks correspondence with amateur astronomers or stargazers. Will respond to all letters. Contact Lynn Stratton, 25 Knox Boulevard, Marlton, NJ 08053.

WANTED – Fifteen-year-old male seeks correspondence with other teens (male or female) worldwide interested in astronomy or science-related subjects. Contact Todd Gable, 17583 Wickman Place, San Lorenzo, CA 94580.

WANTED – Eighteen-year-old English amateur astronomer would like to correspond with others from around the world. Will reply to all letters. Contact Keith Eyeons, 1 The Pastures, Totteridge, London, England, N20 8AN.

WANTED – Celestron C5, Meade 2045, or Quantum 4. Contact M. Mann, 4102 West Orchid Lane, Phoenix, AZ 85051. Phone (602) 939-8555.

WANTED – 1986 ASTRONOMY calendar and any astronomy board games. Contact Frederick Pomerantz, c/o Deep Space Disco, Box 1462, Station H, Montreal, Canada, H3G 2N4.

FOR SALE – ASTRONOMY. 1987-88. $15 per year, $20 with slipcase. *Sky & Telescope*. 1984. $20, $25 with binder. *Sky & Telescope* binders. $7 each. Contact Gary Liberatore, 5103 Hamilton Avenue, Baltimore, MD 21206. Phone (301) 488-6297.

FOR SALE – 4-1/4" f/10 Newtonian on old-style Edmund German equatorial mount. No eyepieces or finder. $100 pickup or pay shipping. 25mm and 40mm MA eyepieces. $30 each. 6mm and 12.5mm Ortho. $35 each. 9.7mm Plossl. $55. Amici diagonal. $35. Novak 15-5/8' diameter RQ HD spider. $22. Contact John Stewart, Box 518, Holser Road, RD#2, Manheim, PA 17545.

FOR SALE – 80mm Super Finder. 7x50 wide-angle finder, 9x63 correct image finder. 55mm Plossl. 2.6" enhanced diagonal with holder. Will trade all for Widefield, Koenig, Erfle, and Brandon oculars or refractor objectives. Best offer. Send SASE. Contact David Bernson, 2624 Alden Street, Salt Lake City, UT 84106. Phone (801) 467-2126.

FOR SALE – ASTRONOMY. 1984-88. *Sky & Telescope* 1984-85 and January-August 1987. $24 per year plus shipping. Contact Dan R. Hieb, 120 South Sanborn, Chamberlain, SD 57325.

FOR SALE OR TRADE – Celestron 1-1/4" Plossl 10mm and 26mm eyepieces with LPR#4 filter. Like new. $100. Will trade for C6 pulse drive. Contact Jerry Travis, P.O. Box 3581, Lacey, WA 98503. Phone (206) 753-2148 (days) or (206) 491-0843 (evenings).

Editorial Position Available at ASTRONOMY

ASTRONOMY Magazine is seeking an Assistant Editor with a solid background in observational astronomy and experience in editing and/or writing to join our editorial staff in Milwaukee, Wisconsin.

The Assistant Editor will edit feature articles and regular departments as well as operate our Macintosh and PC-based publishing systems. Familiarity with computers essential. Publishing experience desirable.

Send resume, samples, and salary requirements to: Richard Berry, Editor-in-Chief, Astronomy Magazine, 1027 North Seventh St., Milwaukee, WI 53233. Kalmbach Publishing Co. is an equal opportunity employer.

Patented Performance from the Recognized Leader

See with your own eyes what the U.S. Patent Office saw in Tele Vue eyepieces. Unique optics that provide the sharpest, widest, highest contrast viewing ever.

How? With computer optimized new designs . . . and multi-coatings, high index glasses, blackened lens edges, black tops, barrels threaded for filters, and parfocalization wherever possible. These one-of-a-kind oculars guarantee dramatically enhanced viewing in any telescope. For example, our 50° field Plössls (U.S. pat. #4482217) are available in focal lengths from 55mm to 7.4mm. Tele Vue 55mm, 40mm, and 32mm Plössls have the largest true fields possible in their barrel sizes. Our Wide-Field eyepieces (U.S. pat. #4525035) provide Plössl-like image quality over a tremendous 65° field, and are available in focal lengths of 40mm, 32mm, 24mm, 19mm, and 15mm. And Tele Vue Naglers, (U.S. pat. #4286844) offer a breathtaking spacewalk experience with their incomparable 82° fields plus the sharpness so essential for fast scopes. And there's more: 1.8x and 2.5x Barlows of matched parfocal design, Rich-Field kits for Celestron and Meade Schmidt-Cassegrains, adapters for Questars and modular eyepiece cases.

The experts agree! An eyepiece buying guide from the Ventura County, CA Astronomical Society concludes: *"One brand stands above the rest in overall quality and wide selection: Tele Vue. In general, a Tele Vue eyepiece of a given focal length will outperform any of its competitors."* Tele Vue is front page news in Japanese astronomical journals as well, testimony to the international recognition of these outstanding American-designed eyepieces.

Visit your favorite dealer today and experience the Tele Vue difference! Or send $1. for our informative literature package. Includes a step by step guide to choosing eyepieces for *your* telescope, and literature on the Renaissance 4" refractor, high-tech mounting and accessories—the world's most versatile telescope system.

Tele Vue 20 DEXTER PLAZA, PEARL RIVER, NY 10965 (914) 735-4044

CELESTRON'S OUTSTANDING LINE-UP

For the ultimate in catadioptrics, look to Celestron. Available in 8", 11" and 14" models, these premier instruments deliver much needed stability, superior optical performance, the finest coatings, and the finest drive systems. Inch for inch, these Celestron systems far outshine the competition.

Each has individually HAND FIGURED optics—painstakingly worked to an exacting 1/10 wave specification. All are available with the Starbright® coating group (a proprietary optical multi-coating group that greatly increases light transmission and improves contrast). All of our 8", 11" and 14" telescopes are manufactured in the U.S. under the strictest optical fabrication, testing and quality control standards in the industry. These precise specifications ensure the highest consistent quality.

Mechanically, our catadioptrics provide structural integrity and stability. Rugged, highly damped mounts make viewing and astrophotography a delight. Portability is not sacrificed however as even the C14 is capable of being transported to remote locations for an evening's observing session.

For those wanting more, a computer controlled version (Compustar) is available in all three apertures. Plus a long list of accessories ready to complement your viewing and astrophotography interests.

Visit your Celestron dealer today to preview Celestron's outstanding line-up of quality 8", 11" and 14" telescopes.

CELESTRON®

CELESTRON INTERNATIONAL

2835 Columbia Street • Torrance, CA 90503 (USA)

Telephone: (213) 328-9560, (800) 421-1526 (Continental USA)
Fax: (213) 212-5835 • Telex: 182471